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SHUNTING ENGINE, LONDON AND NORTH-WESTERN RAILWAY.

We give a perspective view of a four-wheel coupled shunting engine for the London and North-Western Railway, this engine being of a type which has been designed by Mr. Webb with a view to facilitate shunting operations at the docks and goods yards and to do that work which is now usually done by horses. The engine differs in detail from those in ordinary use, inasmuch as the driver stands at one end of the engine, while the fireman is at the other end—so that either of them can hook on to a wagon without getting off the engine—a light flexible coupling of rope or leather being substituted for the ordinary draw-link. The brake and reversing gear are arranged so that they can be worked from either end of the engine.

The firebox and firebox casing are made semicircular at top and bottom, with stayed flat sides, the firebox being about 30 in. long, with a combustion chamber extending into the barrel of the boiler and fitted with a Galloway tube; the chamber is connected with the smokebox by 120 horizontal brass tubes 1¾ in. in diameter. The firebox is fitted with a water-tube firegrate, a system which has been in successful operation for the last eight or nine years in the larger type of four-wheel shunting engines, used by the London and North-Western Railway Company. The smokebox, instead of being an appendage to the boiler, is in this case formed inside it, the water circulating all round, and the chimney is carried through the dome, thus acting as a superheater for the steam. The regulator is fixed to the dome, and all the necessary mountings are taken from the same casting, so that only one joint with the dome is required.

The motion is of Allan's straight link type; the valve rods and suspension links are made of malleable cast iron, and the reversing shaft and eccentric rods of cast iron. The slide valves are circular and 6½ in. in diameter, the lap being ½ in. and the lead $\frac{1}{16}$ in.

The four eccentric sheaves are all cast in one, and are clipped on the axle. The coupling rods are of steel, each being composed of two bars having brass ends cast on, a plan which Mr. Webb introduced in some of his shunting engines about nine years ago. The pattern will be readily seen from the engravings.

The frames, which are made of steel plates ½ in. thick, form the sides of the tanks at each end of the engine, and are made sufficiently deep to carry an angle iron footplate on each side at the ordinary height.

The following is a list of the principal dimensions of the engine, and we may add that this type has proved a very successful one:

Heating Surface.	sq. ft.
Firebox	38·41
Water tube firegrate	6·97
Tubes and Galloway tube	197·70
Smokebox	6·93
Chimney	7·85
Total heating surface	257·86

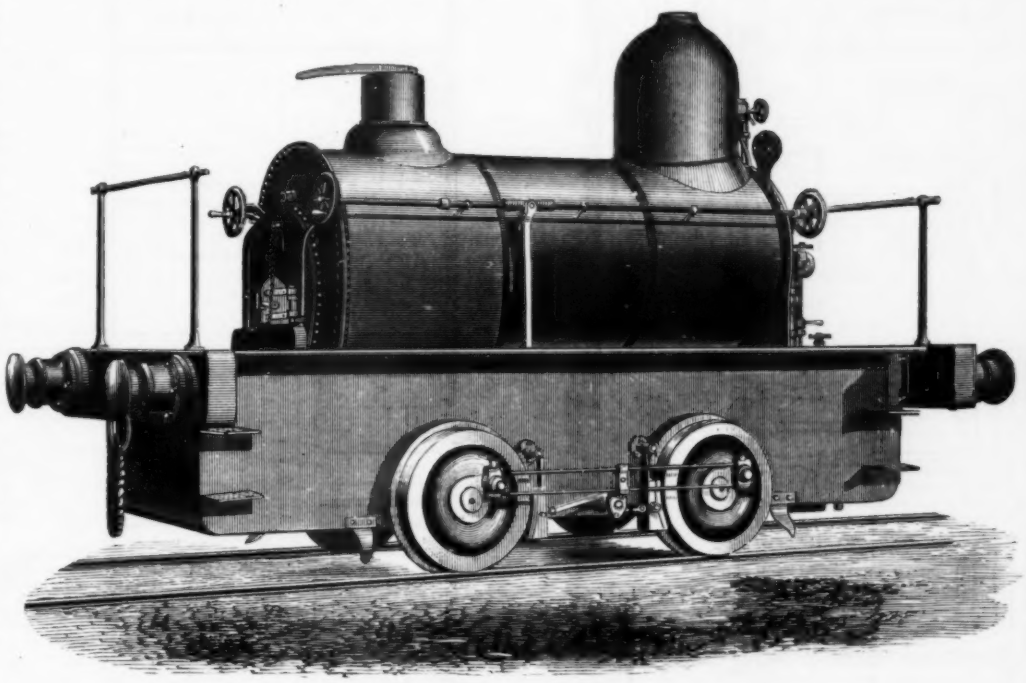
Firegrate area = 5·47 square feet.

Cylinders and Motion (straight link).	ft.	in.
Diameter of cylinders	0	9
Stroke of piston	1	0
Diameter of piston rod	0	1½
Length of connecting rod	4	4
Length of eccentric rods (cast iron)	2	9
Throw of eccentrics	0	3
Slide valves (circular)	0	6½ dia.
Travel of slide valve, in full gear	0	1⅞
Lap	0	0½
Lead	0	$0\frac{1}{16}$

Wheels and Frames.	ft.	in.
Diameter of wheels	2	6
Distance between centers of leading and driving wheels	5	6
Width of tires	0	5⅛
Distance between frames	4	2
Thickness of frames (steel)	0	0½

Water Tube Firegrate.		
Length of tubes	2	9
Diameter of tubes (outside)	0	1⅜
Number of tubes (iron)	13	

Tanks.	
Capacity of tanks	260 gallons.



SHUNTING ENGINE, LONDON AND NORTH-WESTERN RAILWAY.

Boiler (Steel).	ft.	in.
Thickness of plates	0	$0\frac{13}{16}$
Length of barrel	7	3
Diameter outside	3	9½
Length of tubes between tube-plates	3	6
Diameter of tubes (outside)	0	1¾
Number of tubes	120	
Diameter of chimney	0	8½

Weight of Engine.

Weight of engines in steam with 6 in. of water above firebox, 260 gallons of water in tanks, and 1 cwt. of coal on footplate:

	tons.	cwt.
Leading wheels	7	11
Driving wheels	7	12
Total weight of engine	15	3

—*Engineering.*

EFFECT OF MAGNETISM IN TOUGHENING IRON.

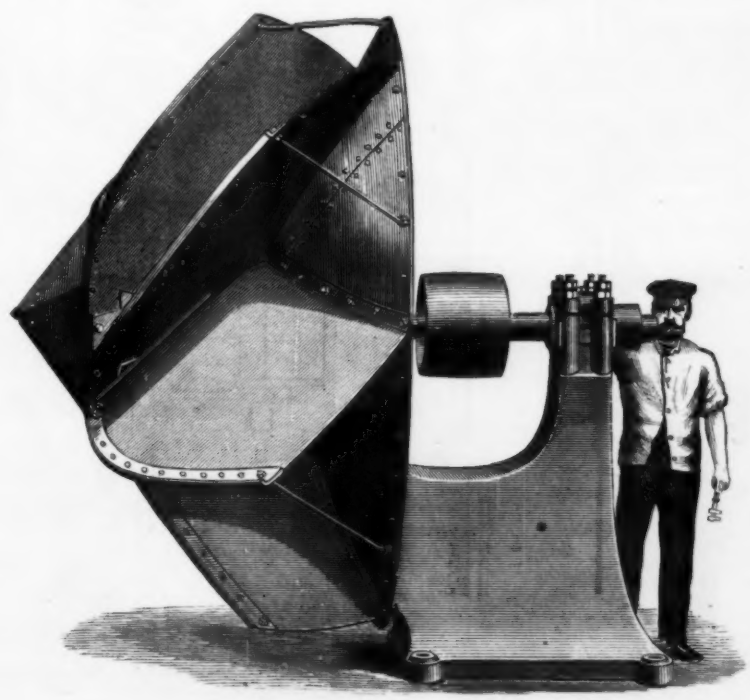
The *Lumière Electrique* states that M. Piazzoli has just undertaken a series of interesting experiments to demonstrate that magnetization increases the toughness of iron. Ruhmkorff had already prepared us for believing that such must be the case by showing that a piece of magnetized iron acquires a hardness greater than that of tempered steel, and such that a file will have no effect on it; but it was interesting to know whether this hardness was at the same time accompanied by a condition of toughness. M. Piazzoli's experiments were performed with iron wires about fourteen inches in length, stretched over supports, and covered with four magnetizing spirals through which the currents were sent sometimes in one direction and then in the other. By this means, the magnetic effects could be produced or annulled in the iron wire without changing the thermic effects developed at the same time by the action of the current. The following are the results obtained with the specimen of wire employed, the weight of which was 0·299 gramme per meter: (1.) When the wire had been annealed with charcoal the weight necessary to break it varied from 1,260 to 1,300 grammes under the influence of magnetization, and from 1,213 to 1,250 when unmagnetized. (2.) When the wire had been annealed in oxide of carbon these weights were 1732·4 to 1742·7 with magnetization, and from 1703·62 to 1719·87 without magnetization. (3.) Finally, when the wire had been annealed in hydrogen the weight necessary to break it when magnetized was from 1289·5 to 1310·1, and from 1263 to 1299·7 when unmagnetized.

Although the differences between the larger and smaller figures of each of the two series are at times contradictory to the conclusion announced at the beginning of this note, the summary of the eighteen series of experiments has shown that the breaking weight of the magnetized wire was from one to three per cent. greater than that of non-magnetized iron.

PELZER'S SCREW VENTILATOR.

We illustrate an exhausting ventilator, designed by Mr. F. Pelzer, and of which several specimens are shown at the Dusseldorf Exhibition by Messrs. Petry & Hecking, of Dortmund.

As will be seen from the perspective view, the ventilator is mounted upon an overhanging shaft running in two bearings, which are cast in one piece with a solid base. The ventilating screw or propeller consists of three parts: a flat cone of the maximum diameter of the ventilator forms the back, a more acute cone being placed in front, and a series of eight wings, equally pitched, are set spirally on the larger cone. All these parts are made of sheet iron, except the boss to which the two cones are fixed, as shown in Fig. 3. The wings are riveted to the cone by means of angle irons and are stiffened by stays. This fan is placed with the front within the air shaft (see Figs. 2 and 3), and is driven at a speed varying according to its size; fans of 4 ft. diameter have a speed of 700 revolutions per minute, while the largest sizes of 10 ft. diameter run at 300 revolutions. The results obtained with fans of this type in various mines in Rhenish Prussia and Westphalia, where a number of them have been at work for a considerable time, are said to be very satisfactory, and the ventilators are claimed to be much more effective than the Guibal fan. They



THE PELZER SCREW VENTILATOR.

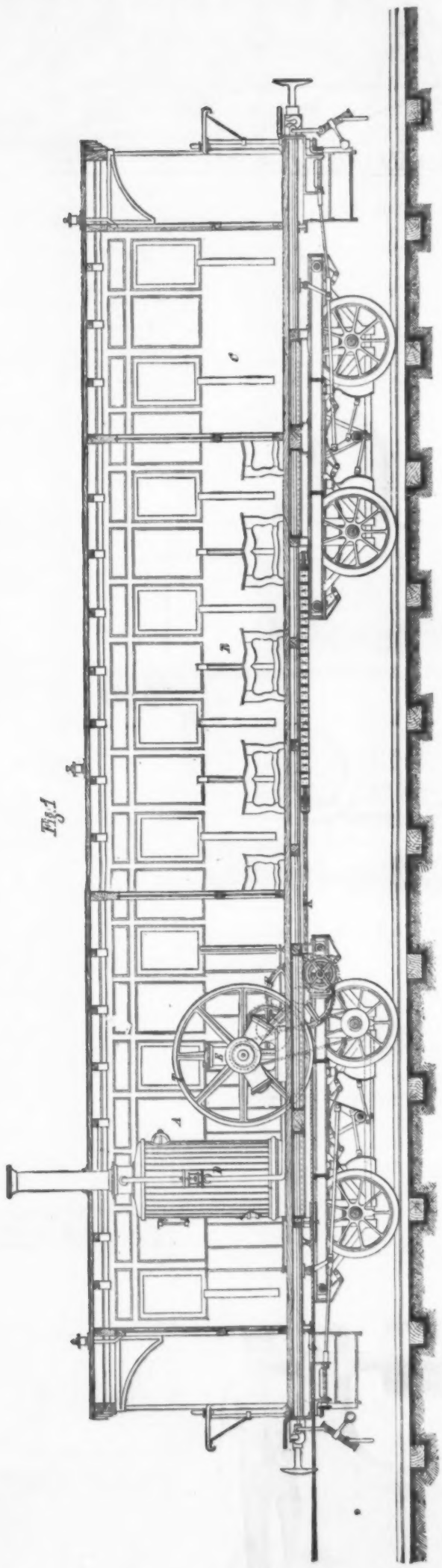


Fig. 1

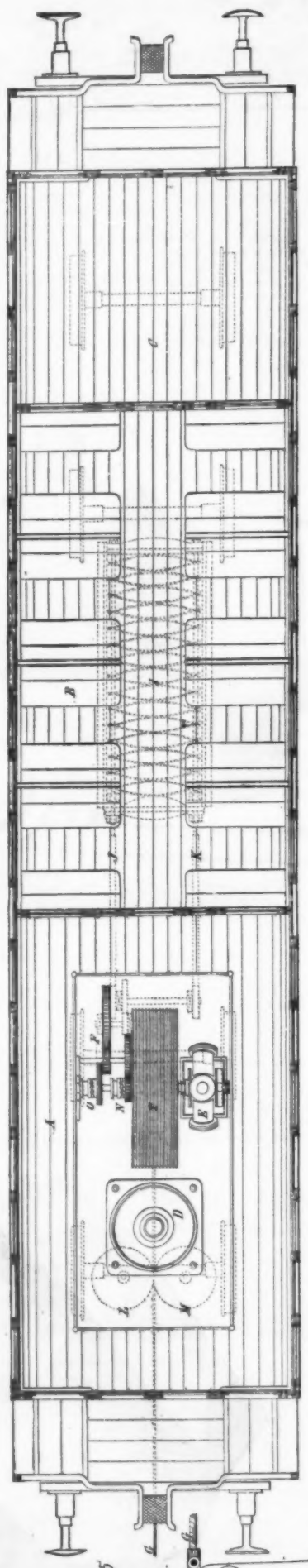


Fig. 2.

Positions après l'accrochage pendant l'enroulement du câble.

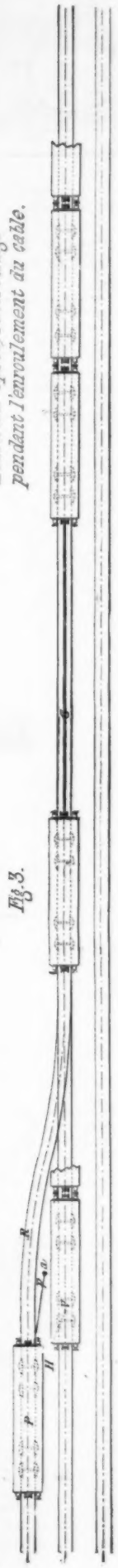


Fig. 3.

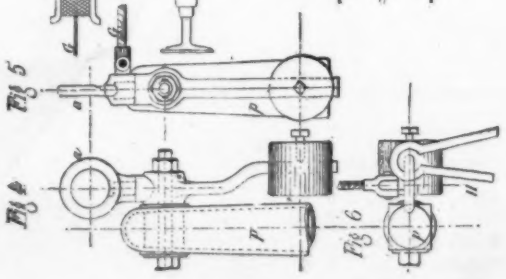
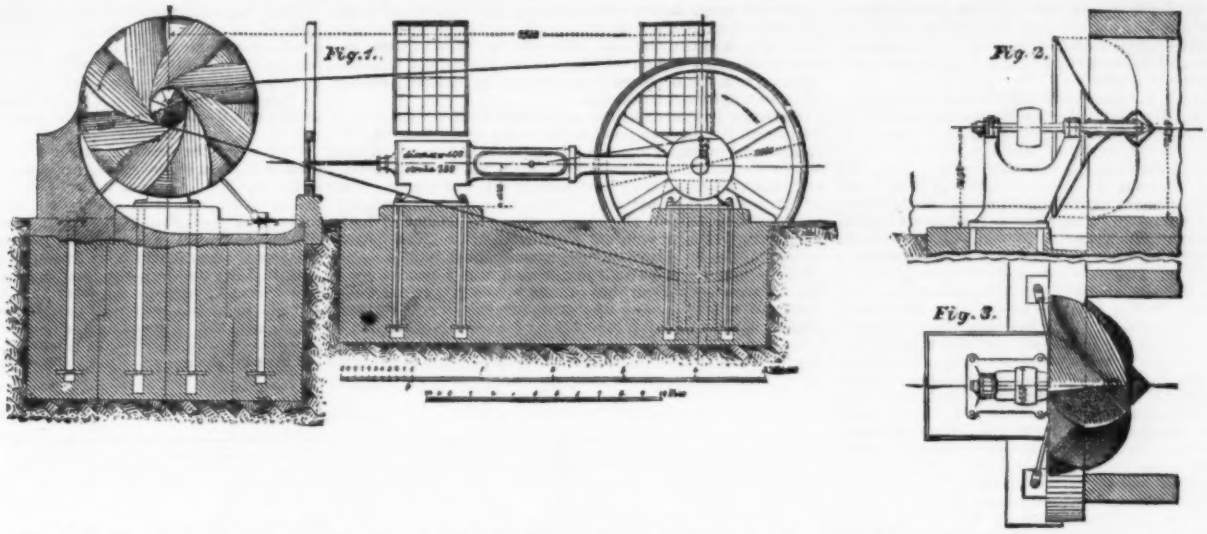


Fig. 5

Fig. 4

Fig. 6



PELZER'S CENTRIFUGAL SCREW VENTILATOR AT THE DUSSELDORF EXHIBITION.

certainly possess the advantage over the latter of being smaller and less costly for the same capacity. Messrs. Petry & Hecking are building these ventilators up to 10 ft. in diameter for an air shaft of 48 square feet area; and this size, when running at 300 revolutions, is stated to produce an exhaustion of 2¾ in. water and remove 120,000 cubic feet of air per minute. Fig. 1 shows the mode of driving a fan direct by belting from the fly-wheel of an engine, and in consequence of the air not being diverted in its course, but only spread radially, the power for driving these fans is asserted by the makers to be less for the same volume of air than that required to drive Guibal fans.—*Engineering.*

TAKING UP PASSENGER CARS BY A TRAIN IN MOTION.

MR. PROSPER HANREZ, a French engineer, has published, in *Revue Industrielle*, a description of his system of connecting passenger cars with a train in motion without stopping the movement of the latter.

Since the ingenious invention of Ramsbottom, express trains are no longer obliged to stop for the purpose of taking in water, but a great delay is still occasioned by connecting passenger cars with them at the different stations. In order to avoid this inconvenience, Mr. P. Hanrez proposes the following arrangement:

A car of special construction, of which we will afterward speak more fully, is furnished with a mechanism by which it can be hitched to a running train without producing a shock, and contains a steam motor. This car is, therefore, a genuine steam car, similar to that which the Belgic engineer Belpaire exhibited at Paris in the year 1878. Mr. Hanrez calls this car a waiting car, because he intends it to serve as a waiting room. The passenger car from one, or even from two or three stations which are near together, is placed upon a side track, R, at the point, P, not far from the main track, and awaits the arrival of the express train. It has the construction of an American passenger car (as in Figs. 1 and 2 opposite), *i. e.*, having a passage way through the center. Besides the above-mentioned motor and mechanism for hitching, it has a compartment, B, for the passengers, and C for the baggage.

We shall now proceed to describe the mechanism for hitching.

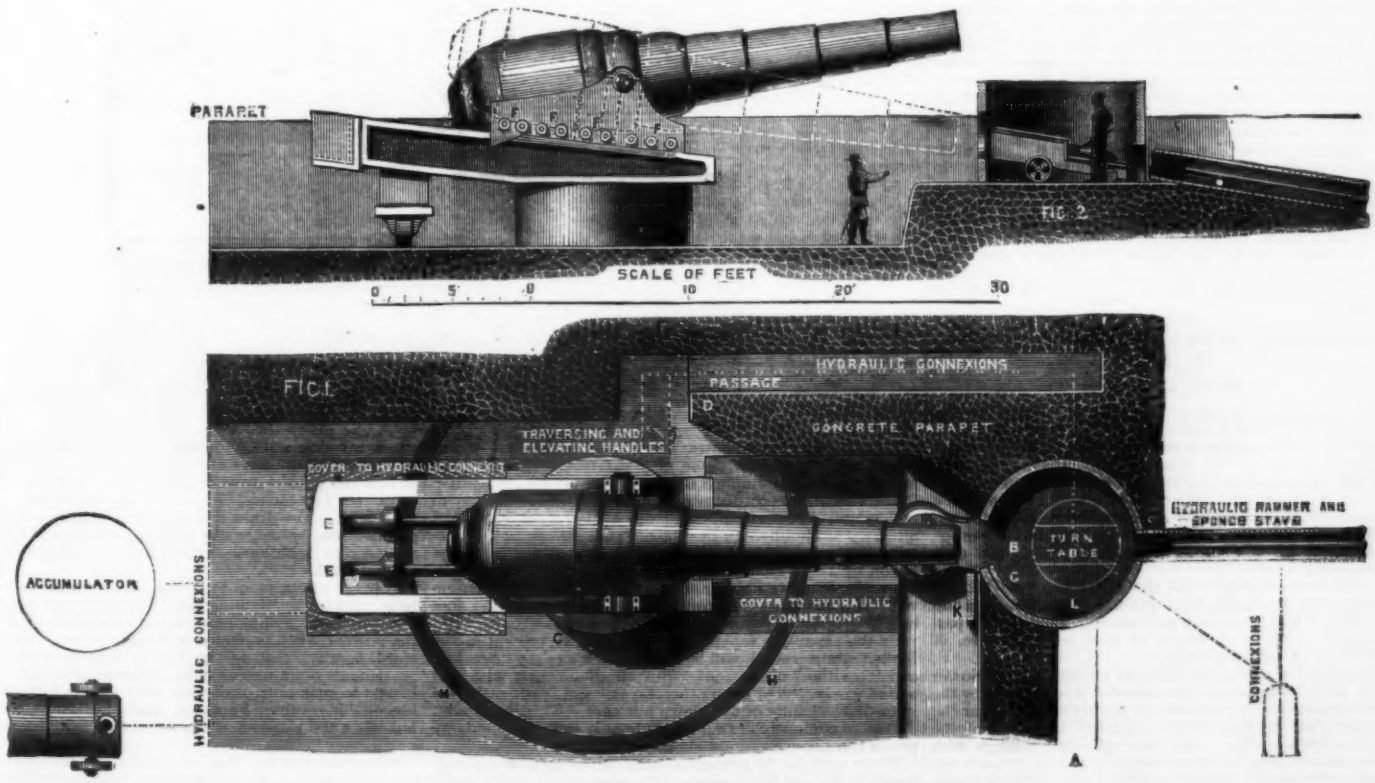
The first thing to be remembered is, that if this car is to be connected with a train in motion without producing a shock, it must have the same velocity, and must run, before the connection, over the same distance as would be necessary if it were to be disconnected from a train in motion and afterward had, at a certain point, to be arrested. Experiments made with the new systems of brakes, especially with that of Mr. Westinghouse, have shown that a train which has a velocity of thirty-six miles per hour may be stopped without shock when its motion has been arrested, three hundred and twenty-eight feet from the stopping point. Therefore the waiting car must have a motor which gives it the velocity of thirty-six miles per hour, after it has run over three hundred and twenty-eight feet. Such a motor cannot be constructed, but the hitching mechanism represented in our drawing produces the same effect in a different manner.

A ring, A (Figs. 3 and 6), which has to be hooked to the train, is connected with the end of a cable, G, which is wound around the drum, T (Figs. 1 and 2). As soon as the cable begins to unroll, the drum by its revolution acts upon a system of tooth wheels, and reduces the velocity in the wonted proportion by means of the braces, K and J, which causes the compression of a series of springs, I. The arrangement is such, that when three hundred and twenty-eight feet of the cable have been unrolled, the springs are compressed to the wonted limit.

If we now suppose that the ring, A, is placed upon a post, *p*, which is furnished with a pivot, then when the train passes, hook, H, which is fastened to the end of the last wagon, will be hooked into the ring, and the cable will commence to unroll, while at the same time the waiting car will be set into motion, at first slowly, but with the continued unrolling of the cable the resistance will increase, and with it the velocity of the car will be accelerated so that it is exactly equal to thirty-six miles per hour as soon as the cable is completely unrolled. Now by means of a mechanism the steam motor, E, rolls up the cable again, and will be aided in this by the springs, which now extend themselves. The car will approach the train just at the moment when it can be connected. The new passengers will now take their place in the express train and the baggage be transferred. When this is done, those passengers wishing to stop at the station will enter the car, and this, being again unhooked, will return by means of its own motor to the station it has left.

TRIAL OF THE NEW 100-TON GUN IN THE ROYAL ARSENAL.

ONE of the four 100-ton guns purchased from Sir W. Armstrong & Co. for Malta and Gibraltar is now mounted and under trial at the proof butts in the Royal Arsenal, Woolwich. It was fired on September 12, on which occasion only a single round was discharged. On September 22, two more rounds were fired, the gun being discharged into the butts. The chief object of the trial is the working of the hydraulic gear by which the gun is traversed and loaded, the behavior of the piece on its carriage, and the convenience of the battery arrangements generally. The gun is mounted on a traversing platform, as shown in Figs. 1 and 2, so as to fire *en barbette* over a concrete parapet from 7 ft. 6 in. to 8 ft. high. This represents the battery in which the piece will be eventually mounted, whether at Malta or Gibraltar, in the former station we believe in the battery known as the Ragged Staff, and at the latter in positions one on each extremity of the harbor works, the western one at a point between Sliema and Tigne of as great command above the sea-level as can be secured, and at the east on a considerably higher point. The battery in the Arsenal is made to represent the conditions sufficiently to enable the trial to be carried out satisfactorily. It will be seen in plan (Fig. 1) that the gun and carriage traverse on circular racers, H H, on a firm foundation of over 3,000 tons of concrete. The weight of gun and carriage and platform is 152 tons. The mounting is on the same general principle as that adopted on board ship, but of course differs considerably in the carrying out. In a revolving turret no provision for traversing the gun is necessary, consequently the gun may be made to move with its trunnions held in small blocks sliding on the fixed slide. Here the traversing platform has to replace the movement of the turret. The gun carriage is, however, kept low and small, moving freely on eighteen trucks, and along the lower edge of each bracket, as in Fig. 1; and the recoil is controlled by hydraulic buffers fixed as little below the axis of the trunnions as may be. On board, to prevent the rolling of the ship moving a gun, it is always necessary to employ toothed wheels and cogged arcs. On land all this is simplified, plain trucks and racers being used. Hence on land traversing becomes comparatively easily provided for and effected, and hence muzzle-loaders, moving into a certain position to receive their charge, have a much



THE NEW 100-TON GUN AT WOOLWICH.

better chance of holding their own against breech-loaders than on board ship, as may be seen from the fact that this gun could be traversed through 180 deg. in fifteen seconds, and it is hoped that it can be loaded and fired at the rate of one round in about two minutes.

In Figs. 1 and 2 the gun is traversed in the direction for loading—that is, it is pointed with its muzzle toward the loading hole of an iron cylindrical chamber or "cage," B. In its position on the works of Malta or Gibraltar there would be two such cages at opposite sides of the traversing circle of the gun. The concrete parapet extending from B past D represents the parapet extending from cage to cage over which the gun would fire, traversing to the nearest cage to load. The gun has to be elevated to fire immediately over the loading cage, but it becomes clear of it by traversing through 17 deg. Hence its available arc of working and firing to sea is 180 deg.—34 deg. = 146 deg. The accumulator and engine here shown in Fig. 1 will be down below the ground level at Malta and Gibraltar. The gun moves very smoothly and easily at the rate we have said, namely, through 180 deg. in about 15 seconds, when worked by the accumulator and hydraulic gear supplied. The accumulator has a weight of about 71 tons. It is here worked by an ordinary steam sapper of 6-horse power, working only at 70 lb. to the inch. It can also be pumped up by forty men with hand pump gear, in which case it is calculated that the gun can be fired at about the rate of one round in 7½ minutes, while if man power is employed without an accumulator it can fire one round in about 15 minutes. The general directions of the hydraulic gear connections are shown in Fig. 1. It is impossible here to enter into a minute description of them. Traversing, elevating, and depressing are effected by moving a handle at D, washing and loading by a handle near L in the cage. The magazine and shell rooms are designed to be below ground, the projectile and charge being lifted on a truck and run into the cage, and brought round on the turn-table and presented towards the muzzle of the gun. The loading hole is habitually kept closed by two covers. The hinged cover, K, is not considered satisfactory and is to be replaced by another. The sliding cover, G, appears to work well. The muzzle of the gun is depressed till it rests in a curved iron support set in concrete, seen in Fig. 1, when its axis is at an angle of depression of 11 deg —not shown in Fig. 2. A bolt is shot out from the cage above it, and thus it is held steady for loading. In the sliding cover, G, is fixed a pipe, from which water is violently ejected up the bore, so as to wash it. Then the sponge head, which also is used for a rammer, is forced up the bore. This is fixed on a wooden shaft, about 6 in. in diameter, and about 50 ft. long. It is free to turn on its axis, and when sent home by hydraulic pressure, follows the spiral course of the grooves. After sponging, the cartridge and projectile are run on to the turn-table, turned, and forced home. The charge is made up in two cartridges, the rear one having a wooden tube forming a passage from end to end, so as to enable the flash from an axial vent to pass through it and ignite the front end of the rear cartridge and rear end of the front one, a small annular primer being employed to facilitate ignition. The charge employed on Wednesday was 441 lb. of P2 powder; 425 lb. had been employed on September the 12th. The shot was a proof cylinder, weighing 2,000 lb., with a gas check on the base. Sponging and ramming home, each appears to occupy about twenty seconds time at present. The gun was fired by an ordinary electric tube, but it is intended to close the vent completely in firing eventually.

The first round fired on Wednesday was not in all respects satisfactory. The working and action of the gun was all that could be wished, but the velocity was only 1,040 ft. The pressure was not, we believe, sufficient to be recorded, and the recoil was only 2 ft. 8 in. On the 12th, a velocity of 1,520 ft. was obtained, and a recoil of about 4 ft. 6 in. It was conjectured that the projectile must on Wednesday have slipped forward again after ramming home, the angle of depression of 11 deg. being sufficiently abrupt for this to be likely to happen with a clean bore. After loading the next round the bore was carefully felt, to make sure that such an occurrence had not again taken place. On firing, a velocity of 1,556 ft. per second was obtained, and the carriage recoiled 4 ft. 7½ in., the weight of charge and projectile being the same as in the previous round, 441 lb. and 2,000 lb. respectively. This bears out the supposition that the projectile slipped forward in the previous round; indeed, it is the only apparent means of explaining the velocity obtained. Of course the use of a wad would prevent the projectile from moving—a contingency which, it may be observed, would be more likely to arise in the case of a tight-fitting sponge, which might have some power of suction in the movement of withdrawal. We understand that no more rounds are at present to be fired from this gun.

The working of the gun is very satisfactory, and most striking as to its smoothness, speed, and apparent ease. It is wholly the work of Elswick, and the design, we presume, of Mr. G. Rendel.

With regard to the guns themselves, we believe that the English Government have adopted as nearly as possible the course recommended by the Italian Committee, that is to say, the form of the entrance to the chamber is slightly altered, and about the same limit laid down for the charge.—*The Engineer.*

BLASTING AND BLOWN-OUT SHOTS IN FIERY MINES.

By W. PURDY.

Now and again when the public mind is excited by the report of a great colliery explosion, the subject of the following observations becomes an almost general topic of discussion among the mining community. Blasting is very frequently named as the possible and probable cause of an explosion, when the cause is not known with certainty. To the extremely easy possibility of an explosion arising from a blown-out shot may be attributed this general consensus of opinion. It is the aim of this paper to show how easy this possibility is.

Let it be borne in mind that the current of air that is drawn or propelled through the galleries and shafts of a colliery, is really a piston which possesses the property of partial solidity. The applications of compressed air are, of course, proof of partial solidity.

The velocity of this piston depends on the extent of power applied, or, in other words, the velocity is occasioned by the tendency of the piston to become a partial vacuum near the point where the drawing power is applied, the air from the downcast rushing forward and through the workings with a speed proportionate to the tendency of the air nearest the power to become a vacuum. When this piston becomes broken at any point between the drawing power and the downcast, the circumstance will be attended with danger, either by accelerating the speed of the return air, or by drawing back the inflowing air. By either of these conditions, a partial vacuum will be formed in the workings, between the two points of the broken piston, and simultaneously with the occurrence of the partial vacuum, danger of an indefinite nature ensues.

There are several causes in connection with mining which will break the air piston or current. As an illustration, the following circumstance, out of several, happened in the writer's experience. The winding rope broke in the downcast shaft, allowing the loaded cage to fall a distance of 40 or 50 yards. The air current was increased to a mighty rush, putting out all the lights, and at a distance of 1,000 yards nearly threw men off their feet. Dust was driven about in heavy dense clouds, accompanied with a most alarming noise. A lull ensued, which was followed by a second great rush of air, but of much less power than the first. In a few seconds the current regained equilibrium. The explanation for the two rushes of air appears a simple one. When the cage began to fall, it carried the air before it with a velocity proportionate to the momentum of the falling cage. This momentum being much greater than the pressure of the atmosphere, a partial vacuum was formed behind the falling cage, into which the air again rushed with a less speed than the first rush, but still greatly higher than the ordinary velocity.

In another case in which the rope broke in the upcast shaft, the loaded cage falling about the same distance as before, the consequences were more alarming. The inflowing air was momentarily reversed and the effects felt at a distance of a mile from the upcast. Doors, in this instance, were dashed open, dust and small coal flying about with considerable force. For a few seconds after the rush the air seemed almost at a standstill, but presently the two ends of the air piston reunited with a second violent rush, and the air current was restored.

These partial vacuums may be caused in a less degree by materials falling down the shaft, such as trams, ice, water, etc., also by main doors being left open—hence the danger of blasting in fiery mines. Fast shots have likewise been known to put out lights, open doors, and blow heavy clouds of dust about at a distance of 300 or 400 yards from the shot.

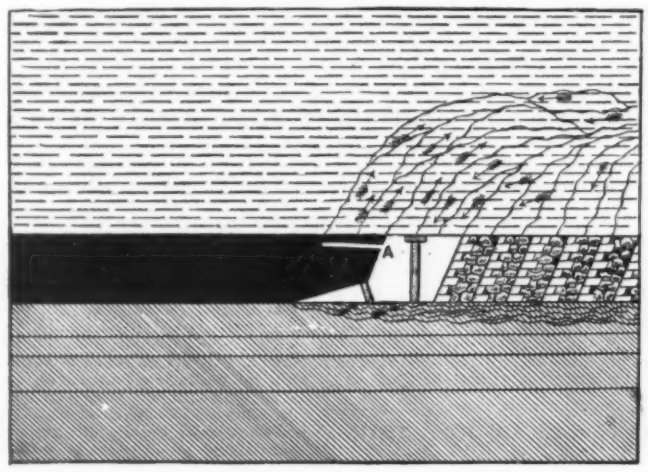
The force of the sound wave depends much on the hardness of the material blasting. Consequently, upon this hangs the degree of vacuity. In material of a medium hardness, and intercepted with "breaks," etc., the sound wave is seldom perceived. But the danger is none the less. In this case the powder will frequently expand into the breaks and fissures of the roof or other strata with very little report.

On hearing the report of a shot, a miner can generally form some idea of the amount of work done by it. If the sound be slight, the shot is assumed to have done very little useful work, and it is concluded that the "breaks" have robbed the shot of its lifting force. In many of these shots little or no smoke is seen until a portion of the material is cut down, when it will pour from the fissures of the roof with rapidity and at a high degree of temperature.

It will now, perhaps, be clear that where smoke can be forced, the same cavity may have formed a reservoir of gas. There are also forced flames or sparks from the shot or powder. Ignition follows as a natural sequence.

These breaks are admittedly the seats of firedamp, and as they exist multitudinously and all their ramifications are connected, they form a vast magazine of stored up danger, unseen and too often unsuspected. Lurking there, just on the surface of the air current, it only needs a spark from a shot to make the gallery a center of destruction.

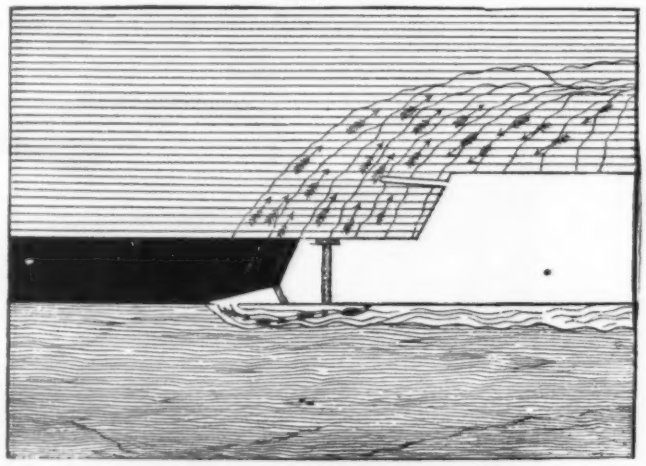
PLAN 4.



The accompanying drawings will make this position clearer. Fig. 4 represents the coal undercut, having a hole, A, bored, ready to receive a charge of powder. Miners generally understand to ram home the powder to the far end of the shot hole, as that is the place where the maximum power is required. At the rear of the hole a fissure, an inch or two in breadth, will sometimes occur. This will occasionally extend to a great height, and be connected with innumerable other fissures. At this point also the coal is in an active molecular condition from the superpressure; consequently, gas is given off copiously, and stores itself in the breaks, fissures, etc., of the roof, etc. When the shot is fired the flame expands into the breaks, when, should gas be stored, the result is an explosion.

Fig. 5 shows a hole bored in the roof, which is of a harder structure than coal. (The system of blowing roof down is necessary in thin seams for the purpose of making good-sized traveling ways.) When a hole is bored into a break in the roof, a skillful workman will bore beyond the break, so that the powder may lie on the other side of it, or he will stem up a few inches, so as to get it out of contact on the near side. The traveling road shots are by far more dangerous than shots in the coal, inasmuch as the powder is exploded at a higher level in the breaks, where gas may be accumulated.

PLAN 5.



It is not uncommon for stone hole shots to blow through into cavities containing gas. It may also happen that, when several fissures are close to the far end of the hole, the powder when exploded will spend most of its force upward, because that is the line of least resistance. These are dangers of an unseen character, and, although little heed is paid to such sources of risk, they are often attended with lamentable results. Shots of this kind make little noise, but when the material is hard and free from breaks the report is very loud.

When the shot is a fast one, which occurs if the line of least resistance lie in the direction of the stemming or, what is the same, an insufficiency of powder for the work required to be done, the blast is much the same as a shot from

Experiments have shown again and again that sound waves will force the flame of a safety lamp through the gauze, even by so simple a means as a pistol loaded with a few grains of gunpowder. A step farther will enable us to understand the results arising from a blown-out shot in a mine. The shot hole in the above case answers to the pistol. Whenever a charge of powder is blasted in a mine the piston of air is more or less broken, and the ventilation momentarily driven hither and thither. The partial vacuum will, of course, be greatest in degree close by the shot hole.

By the expansive force of the shot, gas, if present in the broken strata around, will be pressed back into the "breaks" and "cavities" of the roof. But simultaneously with this action gas is ejected from other breaks and fissures in the immediate vicinity of the blown-out shot. This, no doubt, occurs so copiously at times that there is sufficient firedamp present to cause a serious explosion.

There will also be present a varying proportion of carbonic oxide, and there exists a divergence of opinion as to whether a mixture of that gas and firedamp will explode at a certain temperature.

a cannon. The difference is that, in the case of the cannon, the air is pushed aside, but in that of the fast shot it is compressed in the gallery by the concussion of the shot. The ventilation current is therefore accelerated at one point, retarded at another, doors are forced open, the air system is disordered, a partial vacuum ensues near the blown-out shot, into which gas pours from a million minute reservoirs, then, as a second rush of wind restores the ventilation, the gas is drifted into a naked light, or through the meshes of a so-called safety lamp, and the result a too familiar catastrophe.

A circumstance of a blown-out shot occurred a short time ago, under the writer's notice, in a well-ventilated mine, in which the shot hole was bored about forty inches into the bind for the purpose of bringing down the roof. The hole was charged with three cartridges, each containing eight ounces of gunpowder. When the powder was blasted, it merely blew out the stemming, but its effect on the ventilating current was something fearful. Clouds of dust were carried with terrific force, sweeping out all lights for a considerable distance. At seventy yards away men's clothes were covered with dust nearly half an inch in thickness. Two doors, with a great ventilating pressure against them, 700 yards away, were flung back with violence. On this matter being investigated, and the blaster being questioned it was found that the cartridges, being put in separately, were not stemmed close to each other; also, the diameter of the shot hole was much larger than the cartridges, consequently the powder was not sufficiently confined to force down the roof; but its effects were none the less on the ventilating current or air piston.

So recently as May 19 of this year an explosion occurred at the Kiveton Park Colliery, near Sheffield, which resulted in the death of four men. From evidence given it was found that the explosion originated from a blown-out shot. The shot hole was bored seven inches over the fast, and must have been charged with one and a half pounds of powder. Safety lamps were used in that part of the mine. Two of the men, however, were found a distance away from the place where the blasting was done, who had evidently been making their escape. A third was found much nearer, sitting in an easy position. The underviewer, who was first of the explorers, at first sight, thought him to be alive. None of these men, however, were burnt so badly as to cause death. The survivors gave evidence of the fearful shock in the ventilation, which dashed them about like birds in a whirlwind; their bodies were more or less bruised. Had this been a badly ventilated mine, and the air current impregnated with firedamp, the effect of this fast shot was sufficient to have set the whole mine in flames, consequently the five hundred men they employ must have been ingulfed in a flaming sepulcher. In this case, and many others, the ventilation was the means of saving the lives of the employed and the property of the employers. The ventilation was restored in a few minutes after the shock, consequently its effects were felt only in the one district where the blasting was done.

Fast shots are too often the result of inexperience or foolishness on the part of workmen, from such causes as taking too much thickness for one blast, boring their hole too deep in narrow places, having no loose side, an insufficiency of powder according to the hardness of the material, not properly stemming the powder, boring their holes over the fast, etc., etc. These, with many other causes in connection with blasting in fiery mines, have resulted in painful disasters, which are year by year hurrying hundreds of our miners into eternity.—*Colliery Guardian.*

THE LONGEST BRIDGES OF THE WORLD.

THE new bridge which has been built for the Orenburg Railway over the Volga, at a distance of seventeen versts from Syzran, in the Saratov government, is now completed, and exceeds in length all other bridges yet constructed, with the exception of the Victoria Bridge over the St. Lawrence at Montreal, which is very nearly one and three-quarter miles long. The great bridge at Sloerdyk, over the Hollandsch Diep, near the mouth of the Maas, in the Netherlands, which now takes third instead of second rank among the longer bridges of the world, is shorter than this Volga bridge by six meters. The length of this new bridge is stated to be 696 saschenes, or 1,485 meters (=1623·986 yards). Its building was commenced on August 17, 1877, so that it has taken just three years to finish. The cost has been 4,630,000 rubles, or nearly £694,500. Four hundred thousand puds of iron, or 6,552,400 kilogrammes (=5,149 tons very nearly), have been employed in the construction. The bridge rests on thirteen arches, and the plans were prepared by Prof. Beleloubsky, of St. Petersburg. After this new Volga bridge and the Dutch bridge, at Sloerdyk, over the Hollandsch Diep, already mentioned, the next longest bridges in Europe are the two over the Dnieper, Kiev, and Krementschok respectively, in the government of Pultova, the former of which is 1,081·68 meters (=about 1,182 yards), and the latter 975 meters (=1,065 yards 2¼ feet) long. Then comes the bridge over the Waal, at Bommel, in the Dutch province of Gelderland, 917·4 meters (=1,002 yards 2 feet) in length. Next in length is the great Mississippi bridge, connecting East St. Louis with St. Louis, which was built between 1869 and 1874, and cost $10,000,000, or almost three times as much as the new Russian bridge; it is 772·32 meters (844 yards) long, and rests on three arches, the middle one having a span of 158 meters. The bridge near the mouth of the Vistula, at Dirschau, in East Prussia, follows, and the Dutch railway bridge over the Lek, at Kuilenburg, on the line between Utrecht and Boxtel, which are 706·19 meters (=761 yards 2½ feet) long. Next comes the Britannia Tubular Bridge, which is more remarkable for its admirable construction than its length of 556·84 meters (=almost 608 yards 2 feet). The bridge between Praga and Warsaw, 507·77 meters (=555 yards) long, comes next; and then the fine Alexander Bridge, only finished last year, between the Finland bank of the Neva and St. Petersburg, which is 405·36 meters (=447 yards) long, considerably less than a third of the length of the new Volga bridge, and about a seventh of that of the Victoria Bridge.

AMERICA'S RIVER SYSTEM.

HAS any fanciful person, with a commercial turn of mind, and with a deeper interest in the development of the great trade avenues which nature has marked out than in the highways constructed wholly by human art and mechanism, ever taken the trouble to imagine what the river system of America will be when perfected as it may be, and as it doubtless will be, when the lapse of centuries shall make this the populous country of the world and masterful in art, commerce, and all science?

To map out in fancy all the schemes which must seem not only feasible, but likely to be accomplished as time passes—unless a new motive power be discovered which shall vastly cheapen all present modes of transportation—cannot but seem Quixotic to the ordinary and unfanciful observer, while, in fact, their accomplishment would not embody a tithe of the extraordinary features that have been contained in the modern application of steam, and the utilization of many other recent expositions of science. Probably no fact was ever developed which long anterior to that development did not have its counterpart in fancy, and, therefore, no picture which plain natural law does not declare to be outside of the realms of the possible, should be thought an exaggeration—a mere vision, possessing no phase possible of fulfillment.

If, therefore, any enthusiast be heard to prophecy that the United States—which will then doubtless include all of North America—will one day be traversed by steamships from the Atlantic to the Pacific, and from the lakes of British America, the great lakes, the eastern rivers, and the streams running down the western mountains to the Gulf, he should not be condemned as a fool or a visionary without a close examination of the map of North America, and without indulging in serious speculation as to what engineering, in its wonderful progress, is capable of accomplishing.

Let such an enthusiast have full sway, and he will explain to his audience first how the rivers of the East may be utilized for steam navigation. New England has several rivers which might be improved so that navigation would be extended much farther into the interior than at this time. In New York the Hudson, with its broad expanse, rolls down from the beautiful lakes which lie adjacent to the St. Lawrence, and these in turn have streams flowing into them which could easily be made a connecting link between the river which is the pride of New York and that greater one which carries the waters of our vast inland seas through British territory to the Atlantic Ocean.

Coming to Pennsylvania, we find a vast field for the exercise of that theoretical river improvement which may one day become a fact. The Delaware and Schuylkill could be utilized to a far greater extent than at present, though they could not be transformed into important connecting links with other waters, as some of their sister rivers may be. The Susquehanna offers the most splendid inducements to the theorist. Its head waters lie so near the smaller lakes of New York, which might easily be connected with the great lakes, that any one can see what a grand commercial avenue it could be made. If its own waters, by judicious conservation, should be found insufficient for the use of vessels, an ample supply could be had from the lakes, which would be tapped? Again, the Susquehanna could be wedded to the waters flowing to the Gulf by the route proposed by General Harry White, or by some other way which a survey would discover to be feasible. Any who have traversed the line of the Pennsylvania Railroad will doubtless know how readily the waters of the Juniata and Conebaugh could be united, the former leading to the Susquehanna, and the latter to the Allegheny by way of the Kiskeminitas.

Again, the Allegheny, with its great volume, could easily be made a connecting link between the Ohio and the great lakes, first by tapping Chautauqua Lake to mingle with its head waters, and then by uniting Chautauqua with Erie by a canal of eight or ten miles in length. This could be made one of the most magnificent water ways in the country, and would be a great avenue for commerce.

There are several other schemes besides the one mentioned for joining the Atlantic with the Gulf waters. One contemplates a union of the head waters of the Youghiogheny and the Potomac, another the connection of the Monongahela with another branch of the same stream, another a junction of the Kanawha with headers flowing into the Atlantic. All of these schemes look to the grand desideratum of uniting the navigation of the western rivers with that of the Atlantic Ocean. Of course, before this is done, or before such a brilliant intermarriage of rivers could be made to bear fruit, the Ohio, at least, if not the Mississippi, would have to be improved, that it could be utilized at other times than when the spring freshets, the summer solstice, or the autumnal equinox, furnish a sufficient supply of water to float a flatboat laden with coal.

Going west to the Mississippi, examination of its northern course shows how readily, in a day of great engineering, that Father of Waters might be connected with the greatest lake in the world, thus completing a grand avenue for commerce between the North Atlantic and the vast agricultural regions of the South and West. West of the Mississippi the powerful mind will not lack for similar food for speculation in tracing the possibilities of uniting the waters of the Missouri, Red, Rio Grande, and other rivers, with those of streams having their origin high up on the Pacific water shed.

Those interested in these matters, and others not immediately or practically interested, may find instruction and diversion in examination of a map clearly defining the rivers of North America, and estimating the work necessary for uniting them to form a network of avenues for steam navigation extending over the whole country. It is a work for centuries, though, and not for years—we had almost said for eternity, and not for time. Yet we can hardly avoid feeling that this is a part of the America of the future. When the great railway lines are all completed, and there are several of what are, by way of distinction, called "competing lines" between the Atlantic and the Pacific, and between the far North and the far South, and when the railway kings of a half century or a century hence "pool their issues" to fleece the public, then that public, three times as numerous and as wealthy as now, will begin to realize, if not before, that there must be some method of transportation of freight which will check the action of railway companies in imposing onerous tariffs. These modes of transportation will necessitate the employment of either water or air, and as the latter element does not promise richly in this particular, the development of rival methods will doubtless be confined to the water.

The keenly-observant reader may see in all this speculation a satire upon river improvement, and when it is considered how the government temporizes in the matter of river improvement the person who indulges in a fancy so far extended beyond that which is at present a subject for so much discussion and so little action, may well be accused of attempting a satire. But we believe that the public mind will wake in the near future to the advisability of great improvements in our water ways, and that, as the years now far distant roll by, the increased wealth, population, and energy of America will bring about the perfection of the system for steam navigation which we have fairly outlined, and which now seems a mere figment of the imagination.—*River Record.*

HOW TO GET LARGE STREAMS.

MR. HORACE SILSBY informs us that when the Holly Waterworks were tested at Rochester, N. Y., he saw a three-inch stream thrown directly from the hydrant 300 ft. perpendicularly. He says it looked like a tall, thin liberty pole, so steady was it. At the same time a two-inch stream was thrown horizontally 464 ft. The water pressure at the pump house was less than 100 pounds; according to Mr. Silsby's recollection, only 80 pounds. The secret of this remarkable throwing lies in the fact that the hydrant was located on a large main, and had a bountiful supply of water close up to the nozzle through which it was delivered—in fact, the stream, passing through the nozzle, came directly, and without obstruction, from the great body of water which was being forced through the street mains by the powerful pumps behind it. Why cannot similar results be obtained from our steam fire engines? They are capable of exerting a far greater water pressure, but the results do not correspond. We are aware that it is claimed for some steamers that they can project a stream upward of 300 ft. horizontally, but this measurement is based on the farthest drop of water thrown, and not on the solid stream. As a matter of fact, we have never seen a solid stream thrown 100 ft., much less 300, and 60 or 70 ft. perpendicularly would be a good throw of solid water. What the fire departments in the large cities most require at the present day for fighting fire in tall buildings is large, powerful, solid streams of water, thrown with great velocity. When one of these tall, modern buildings, composed of highly inflammable material, and stored with even more combustible goods on every floor, located in the midst of other buildings similarly constructed, and occupied, takes fire, there is little hope of saving it. The efforts of the firemen are then directed to saving the adjoining property. To do this effectually, they must drown out the fire in the building where it started, and for this purpose solid streams, of great volume and velocity, are required. They are also necessary to reach the cornices and roofs of adjoining buildings. At the time of the Worth Street fire, Chief Bates informed us that he had not an engine that could put a solid stream on the cornices of the building, which were less than 90 ft. above the sidewalk; the best they could do was to throw a spray of water on the roofs, and this was of little account. In such cases the firemen simply have to wait till the fire burns down within reach of their appliances.

The *Journal* has persistently advocated the necessity of getting as large a body of water as near as possible to the nozzle to secure the best results in projecting a stream for fire extinguishment. To this end we have advocated the use of larger hose between the steamer located at a hydrant and the point where the playpipe is attached. Three-inch hose, or even four-inch, would be better than the two and a half inch now in use for this purpose, using it for such distance as the hose is laid in the street. This would virtually make a conduit similar to a temporary street main. When it became necessary to take hose into a building, a lighter grade and even a smaller size might be used than that required for street service, for convenience in handling. With the perfection now attained in the manufacture of hose, there would be no difficulty in making a four-inch hose that would stand the pressure required, and that would be no heavier than much of the hose now in use. By using such hose, a large body of water would be advanced so much nearer the point of delivery, while the pressure behind it would be equal to projecting it to much greater distances than are now attained.

A great difficulty at present encountered in getting effective fire streams is due to the manner in which hydrants are located. Take a street with, say, a twelve-inch main running through the center of it; the hydrants are located at the sides of the streets, on a four-inch pipe connecting with the street main at right angles. In such a case, the hydrant gets only so much water as the four-inch pipe can carry instead of having the twelve-inch main for its supply. The pressure in the large main tends to direct the body of water straight ahead, and the right angle formed by the smaller pipe creates an obstruction that reduces the pressure at the hydrant outlet very materially. In every instance, hydrants should be located on the large mains without the intervention of smaller pipes, whether placed at right angles or otherwise. Hydrants located on a main where there is a constantly moving large body of water will not only deliver more water than if located on a connecting pipe, but they have the additional advantage that they will never freeze. The diagrams below will give a rough idea of how the thing is done, and how it ought to be.

AS IT IS.

AS IT SHOULD BE.

In the case of the curved main, the great body of water has an unobstructed flow at the bottom of the hydrant, and, if the hydrant is large enough, the whole body of water would rise in it as far as the pressure behind it would carry it, and, in addition, the hydrant would never be frozen. In the hydrants as usually put down, the water lies in the small connection, and is liable to freeze in cold weather. The right angle formed by the small connection presents a serious obstacle to the flow of water, and materially lessens the pressure. The hydrant can receive only so much water as is incidentally diverted from the large main into the smaller pipe while seeking a more direct outlet through the large main.

Very much has yet to be learned regarding the science of hydraulics as applied to fire extinction, and not the least important is to solve the problem as to the relation of playpipes and nozzles to water pressures. It is generally supposed that the greater the pressure the more satisfactory the stream delivered from the nozzle. This is not so. We have seen a steamer throwing a very creditable stream under a given pressure; add ten pounds to the pressure, and the

stream was torn into spray soon after it left its nozzle; reduce the pressure again, and the stream took on the solid form once more. An Eastern inventor has recently discovered that putting a thin metal core into a playpipe, so as to divide the stream into four parts—taking the twist out of it—gives far better results. By using this core, a steamer threw thirty feet further than she could with the ordinary playpipe, and the stream sprayed less. While there is much to be learned relative to fire extinguishment, it is good to know that our fire departments contain many scientific men and inventors, and that these are constantly at work on the problems presented by their daily experience. The annual conventions of the Chief Engineers is doing much to develop this spirit of inquiry, and the good results are already being felt.—*Fireman's Journal.*

ST. ANTHONY'S FALLS.

THE Falls of St. Anthony, though possessing immense water power, are not of a very imposing appearance, the slanting apron in a great measure destroying their beauty. The direct fall is some forty-five feet, but within three-quarters of a mile the descent is upward of seventy-five feet. The altitude between the levels of the river at Minneapolis and St. Paul is 110 feet. The whole adjacent country, in fact all the way up from the junction of the Minnesota River, is one vast bed of sandstone of very little coherence, reaching to an indefinite depth, but covered with a layer of compact limestone, generally about twenty feet in thickness. In turn, this is again covered by deposits of gravel and sand.

The recession of the Falls is due to this fact. The immense body of water pouring over the ledge of rock, gradually wears away the soft sandstone beneath, and the limestone being thus left without sufficient support, drops by degrees. The treacherous cave is again formed, and the roof again falls. This process is kept on year after year, and the Falls of St. Anthony, like its monster sister, Niagara, has receded many miles, until, in the former instance, its limit has been well nigh reached. Had no effort been put forth to arrest the recession of the Falls which Father Hennepin discovered two hundred years ago, it is extremely probable that by this time they would have no existence in fact, for so soon as the limestone was gone, the Falls would resolve itself in a long, irregular rapid. The march of civilization also assisted to hasten the Falls to their destruction.

Charters were granted in 1857 by the Territorial legislature of Minnesota to the Minneapolis Mill Company and the St. Anthony Falls Water Power Company, authorizing them to contract such works as they deemed necessary for utilizing the water power of the river at this point. These two companies, the former of which occupied the southwestern and the latter the northwestern side of the river, at once proceeded to take advantage of the provisions granted by their act of incorporation. Sluices and dams were constructed and other works undertaken, to make the best possible use of the immense power lying latent in the dark waters. Lumber and flour mills quickly sprang up, and the nucleus of an enormous trade was soon formed.

By the dams built by these companies, the flood discharge of the river was restrained to 450 feet in width, thus increasing the body of the water at that portion of the Falls, and hastening still faster its recession. In low water, again, the greater portion of the water was drawn through the sluices, very often leaving the limestone ledge nearly bare, and subject to rapid disintegration by the action of the frost.

In 1868 a bold project was conceived to erect mills on Nicollet Island, the power being furnished by means of the water passing through the tunnel constructed beneath the limestone, 2,000 feet in length, and having its exit at the foot of Hennepin Island. This tunnel was begun from the lower end, was six feet square, and entirely without lining of any kind. As it neared Nicollet Island the influx of water was so great that the workmen were compelled to desist, and the tunnel became a roaring sluiceway.

The folly of undertaking the construction of a tunnel without proper precautions soon became apparent, and it was at once seen that the Falls were in danger if this tremendous leak was not soon stopped. The companies concerned took immediate action, the first step being to float a huge raft of timber and brush to the spot. This was at once broken to pieces and sucked into the vortex. In time a cribwork of timber and stone was formed around the opening, and the tunnel was finally closed up. At subsequent periods it was still farther strengthened at heavy expense, and the danger of further leakage reduced to a minimum.

The first attempt to protect the crest of the Falls was made by the companies in 1866, when a timber apron was constructed. This proved insufficient, and was carried away in the spring of 1867. In 1869 another attempt was made, but was unsuccessful, the high water seriously interfering with the work. The survey of the Falls by Major G. K. Warren in 1869, drew the attention of the Federal Government to the necessity of arresting their destruction. The anxious attention of millowners and the citizens was also drawn to the impending danger, and an eminent Massachusetts man, James B. Francis, was summoned to examine the Falls, and to report as to the best means of averting their threatened destruction. The result may be summed up briefly as follows: He reported that three agencies tended to the destruction of the limestone: 1. The recession of the crest. 2. The tunnel. 3. The action of the frost. For the first he recommended a substantial apron of timber, with heavy cribwork at the bottom. For the second, filling the tunnel for 400 feet with a puddle of clay and gravel. For the third, to keep the limestone flooded by low dams. The citizens at once took the matter in hand, and the work of constructing the apron was carried on by a "Board of Construction," appointed by the citizens. The work on the tunnel was supervised by a union committee.

The first appropriation by the United States Government for the preservation of the Falls was in 1870, when $50,000 was expended on the work. Little progress was made in 1871, owing to the break in the tunnel, which necessitated the building of coffer dams and strengthening the embankment already built at the head of the limestone ledge. In 1872 a board of engineer officers was convened at Minneapolis to consider and report on the whole subject of the preservation of the Falls. This board recommended the plan of Col. Macomb, to construct a solid wall extending across the river at the head of the limestone ledge, and between it and another ledge, sixteen feet beneath. At this time the city had expended about $140,000 on the apron, and $95,000 to prevent the further leakage of the tunnel before mentioned. That the subject was one of great and even national importance, and was deemed such by the Washington authorities, may be seen from the fact that the Government has appropriated in all the sum of $550,000 for this work.

In 1874 the board of engineers again recommended the construction of the concrete wall in the bed of sandstone beneath the limestone ledge. The plan was to build this ledge four feet in thickness and thirty-eight feet in height the whole distance across the river, and thus effectually prevent any further leakage. This seemed to be the only sure method of procedure, and was adopted. In July, 1874, work was begun, a vertical shaft being constructed to a depth of forty-five feet below the lime rock to allow the removal of the earth and water and the passage of the workmen. This wall was constructed in vertical sections, which were finally cemented close to the limestone overhead. The work was completed in 1876, in which year the apron, which had been damaged by the ice, was repaired at an expense of $25,000. In 1878 the apron was remodeled and rebuilt in its present shape, at a cost of $31,000. In 1879 the crib work and old coffer dams near the foot of Nicollet Island, having served their purpose, and now forming a serious obstruction to the use of water and power, were removed.

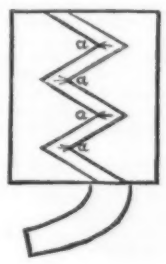
In 1879 the sum of $10,000 was appropriated by the Government for building a sluice way at the west end of the apron, for the passage of logs down the river, without damage to the apron. This was constructed last year. The sluice is 6 feet in width and 346 feet in length. The amount contributed by the citizens of Minneapolis toward the preservation of the Falls is $334,500. This sum, with that expended by the Government, raises the amount to nearly a million dollars.

BREWING IN AUSTRIA.

For Cleaning the Barley and Removing the Germ.—One of the most simple and effective machines that has been introduced for this purpose is the brush cleaner, constructed by Messrs. Duprez & Co., of Rheims. It consists, in the form shown by Fig. 1, opposite, of two pairs of goose-quill brushes, each of about forty square centimeters worked by four eccentrics from the main spindle. The brushes are set from one-quarter inch to three-eighths inch apart, according to the quality of the grain, and have a double action—*i. e.*, as the one rises the other is depressed. The machine can be worked in either direction, but must make at least two hundred revolutions per minute to be effective. The grain and separated particles all fall together on to the coarse sieve, where the larger bodies, such as stones, etc., are caught, while the grain and smaller particles of dust fall through on to a finer sieve below, where they are bolted, and the grain passed on to the spout. From 32 cwt. to 36 cwt. can be cleaned and screened per hour.

Malt Crushers.—The machines mostly employed for this purpose have hitherto been constructed with two chilled rollers of equal diameter driven by gearing, and the pressure regulated by a lever and weight. The principal objections to this system were the power required to drive the rolls, the unavoidable delay of the lever to return to its original position after a temporary displacement, with the consequent inequality of the product, and the noise attending geared machinery. Herr Neubecker's—of Offenbach—crusher is driven direct from the pulley by a strap attached to the spindle of the larger roll, while the two smaller rolls of the same total width as the larger one are driven by the friction of the intervening grain, and are kept in place by two separate India-rubber springs. The general design will be seen from Fig. 2. The advantages are that less power is required to drive the rolls, and should any extraneous matter pass into the machine only one-half of the crushing surface is disengaged until it is got rid of, and the action of the springs is much more rapid than that of the lever and weight. The principle is not new, but the application and mode of execution are decided improvements.

Machine for Preparing the Grain for the Mash.—Nearly every brewery in Austria has some form of apparatus for this purpose, in which the malt is damped on its passage to the tun. In some the water is admitted from above, but the most equal result is obtained when it is subjected to sprays at different stages of its downward journey. We give an illustration of Herr Neubecker's "Vorm aisch apparat," which is in general use. It is made of copper, tinned inside; the grain passes through a series of inclined spouts,



and at the junction of each is subjected to a series of horizontal jets of water, in section as above, where at each of the points marked *a*, a line of small holes admits the water, and forces it into the falling malt. Fig. 3 shows the apparatus attached to the side of the mash tun.

Clearing Battery.—This apparatus is used to prevent the passage of grain, etc., into or through the clearing floor of the refining vat, as is almost invariably the case at the commencement of the operation, on account of the depth of the wort, and its consequent tendency to run off too quickly. As will be seen from Fig. 4, the pipes, A A, connect the under side of the vat below the strainer, with the so-called battery, which consists of a wide copper tube, closed with a cap at one end, and opening into a bent pipe, B, at the other. There is an air pipe, C, on the top, and a blow-off cock, D, below. The cocks attached to the pipe, A A, have sediment pipe and gauge cocks to test the clearness of the wort. The bent pipe, B, is made of nearly the same length as the depth of the vat. The following is the mode of procedure: At the commencement of clearing the pipe, *b*, is allowed to stand upright, and, as the level of the wort sinks in the vat, is gradually depressed in accordance with the remaining depth. By this means a counter-pressure is obtained, which prevents a too rapid filtration, and helps to produce a much clearer wort than when the same is allowed to run off with the pressure arising from the initial depth.

Beer Coolers.—The first operation of cooling takes place in the cooling vessels, as shown in Fig. 5, in which the quantity is gauged by the exciseman. The cooler consists of T-iron straps and iron plates planed on the turned-up edges. The plates are fastened to the bearers by countersunk rivets; each vessel is fitted with a wort valve and a sediment plug. The apparatus used to further reduce the temperature of the wort on its road to the fermentation vats differ according to various opinions. There is the box cooler, as shown in Fig. 6, in which the wort is passed through pipes lying in iced water, the center of the pipe being filled up with an interior tube, closed at both ends, to reduce the quantity of wort in proportion to its outer surface. In cleansing, the knee ends are unscrewed, the interior pipes withdrawn, and the wort tubes scrubbed in the usual way with a brush. Fig. 7 is a similar apparatus—Bömig's patent—only instead of the interior tubes being closed, they are filled with a stream of iced water running in the opposite direction to the current of the wort, so that both surfaces of the latter are subjected to the influence of iced water.

Fig. 8 represents another form of the so-called counter-current cooler, or Batterig, with horizontal tubes. A is a wooden reservoir for ice and water. B, a copper pipe through which the water is returned to the reservoir. C, the induction pipe to the apparatus. D, the eduction pipe to the pump, E, which returns the water to the reservoir. F, a three-way cock to the wort—the short pipe, *a*, is for connection with the water pipes to regulate the water for washing out before and after each operation. G is a three-way cock for the outflow of the beer—the short pipe, *b*, to run off the water used for washing out. H, caps and straps to be removed for clearing out the water tubes, I. The same attached to the ends of the water pipes for cleaning out and withdrawing the twenty-two beer tubes, as shown in cross section, X. K K are the standards on which the apparatus stands.—*The Engineer.*

FRUIT SIRUPS.

AT the late meeting of the American Pharmaceutical Association at Saratoga, N. Y., A. G. Vogeler, of Chicago, read a paper on fruit sirups.

These may be prepared either by combining the juice, expressed from the fruit, with sugar, or the uninjured berries are mixed with the sugar, when the latter will extract the juice, leaving the berries shriveled and tasteless. Among the fruit sirups discussed by Mr. Vogeler, *Sirup of Raspberries* is the most important. He quotes the following different methods of preparation:

1. Contuse the berries, put them into a suitable vessel or vat, add two per cent. of sugar, and allow them to ferment at a temperature of 70–80° F. from three to four days, until the pectin has separated, and no more signs of fermentation are noticeable. Express, let the juice settle for a few days in a cool place, decant and filter. Preserve the juice by Appert's process (introducing the juice into stout bottles, not quite filling them, corking, setting them into a vessel full of cold water, with straw packed between them, so that the water reaches up to the shoulder, and slowly heating the water to boiling; then securing the cork with wax), or convert it into a sirup by dissolving 9 parts of sugar in 5 of the juice, and heating to boiling.

2. A better way is to add at once to the freshly bruised fruit 5 to 6 per cent. of alcohol, then proceed as in No. 1.

3. Crush the berries in a glass vessel with a wooden pestle, add 5 to 10 per cent. of cane or grape sugar, and allow to stand, stirring occasionally. When fermentation is completed the juice becomes clear. Filter and bottle.

4. Put four pounds of the berries into a china bowl with one quart of water containing two and a half ounces of citric acid in solution. Let remain twenty-four hours. Strain, taking care not to bruise the fruit. To one pint of the clear liquid add one and a half pounds of sugar, and stir until it is dissolved.

5. Proceed as in No. 1. When the fermentation is nearly over, express the juice, and add to each pound of it one fluid ounce of deodorized alcohol. Set it aside for one night, filter and bottle, or convert into sirup.

6. Macerate the berries interspersed with layers of sugar, 1¾ lb. to 1 lb. of berries, for twenty-four hours in a cool cellar, and drain off the juice. Preserve by Appert's process.

7. Add to the foregoing product some alcohol or a little bisulphite of lime.

8. Pure fruit juice, 16 oz.; dil. acetic acid, 1 fl. oz.; water, 7 fl. oz.; granulated sugar, 3 lb. Dissolve without heat. The acetic acid is considered by the author as objectionable.

Tests for Determining the Purity of Sirup of Raspberries.—Mix equal volumes of the sirup and of ten per cent ammonia; the color of the genuine sirup changes to a violet with a light tinge of green. If, however, the color changes instantly, or soon, to green or yellow, some foreign vegetable coloring matter is present. If it becomes colorless, or nearly so, it is sophisticated with rosaniline. The latter (or fuchsine) may also be detected by macerating in the sirup some white wool or silk, and rinsing this afterward with water. Water removes the raspberry stain, but not the aniline color. If the fabrics are dipped into ammonia, the aniline dye will vanish, but will reappear on being moistened with acetic acid.

WHAT OUR MILLS NEED.

OUR American mills have undoubtedly made magnificent progress in the past ten years. There is not a department of the mill that has not been vastly improved by the ingenuity of our inventors and the enterprise of our millowners. Everywhere the old has been replaced by the new, and milling has risen to the position of one of the highest of the mechanic arts. Especially have the two last years been productive of great changes and improvement. Any one who has witnessed the scale on which these changes have been made and the rapidity with which improvements have been adopted in our mills certainly cannot accuse the American miller of conservatism, for in some instances the zeal to be abreast or ahead of the times has led to changes which soon had to make place for still further changes. So great a readiness to adopt what is best, or what promises improvement, is quite sufficient evidence of the enterprising spirit of our millers, even if, in some cases, it has not proved financially advantageous. But notwithstanding the wonderful metamorphosis which invention and a progressive spirit have wrought in our mills, there are still some things in which our millers seem wedded to the past. They have hardly as yet, it seems, got the bearings of their new position and new ways of milling, or understood fully what is likely to be required in the early future, at least. For years we endeavored to convince millers that purifying and regrinding were the two things needful. There is no necessity of urging this now. The whole fraternity seems to have an abiding appreciation of the fact that purifying and re-

AUSTRIAN BREWERY PLANT.

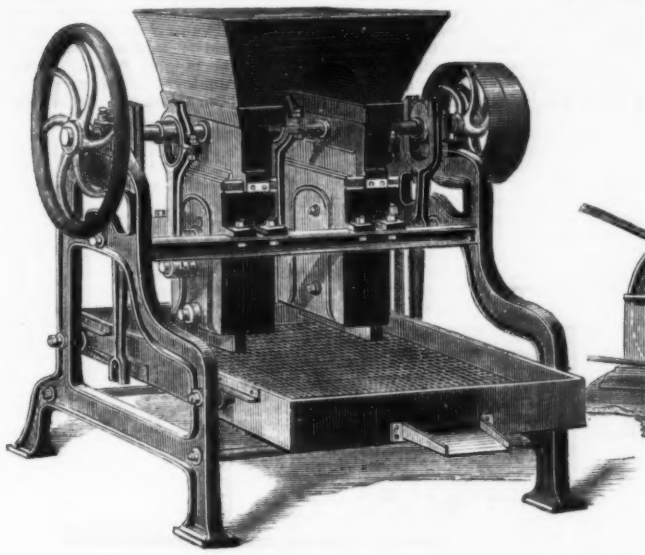


FIG. 1.

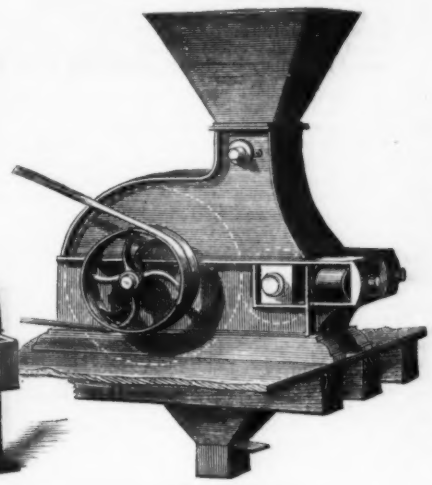


FIG. 2.

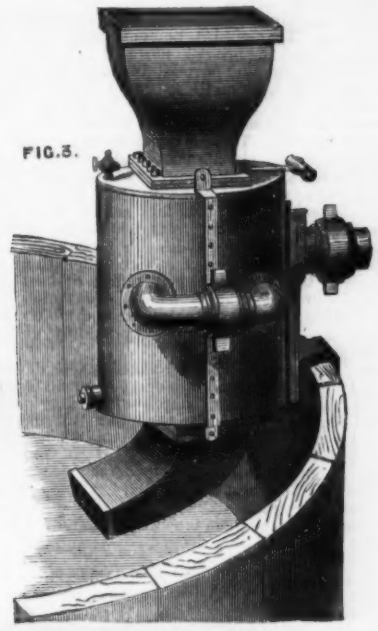


FIG. 3.

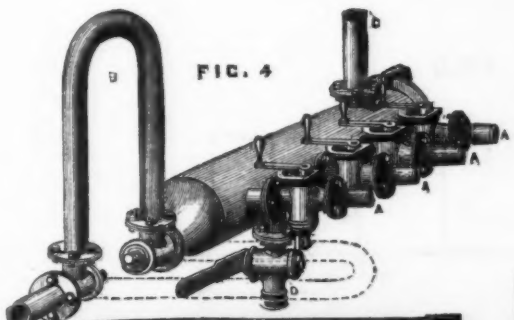


FIG. 4

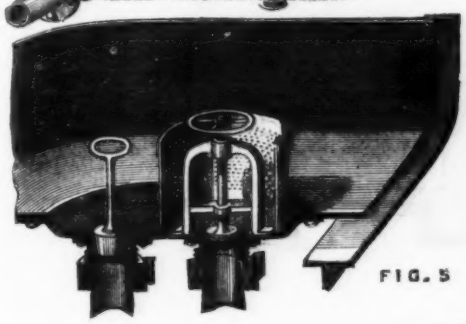


FIG. 5

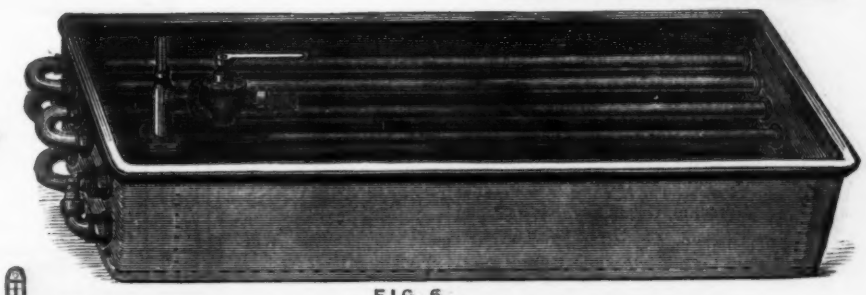


FIG. 6

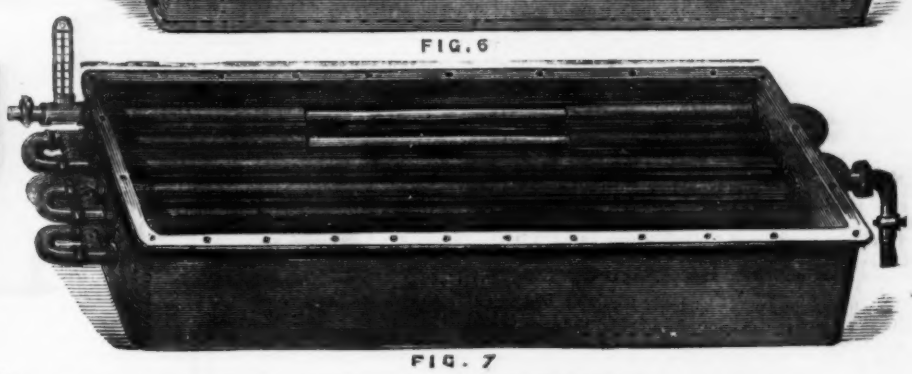


FIG. 7

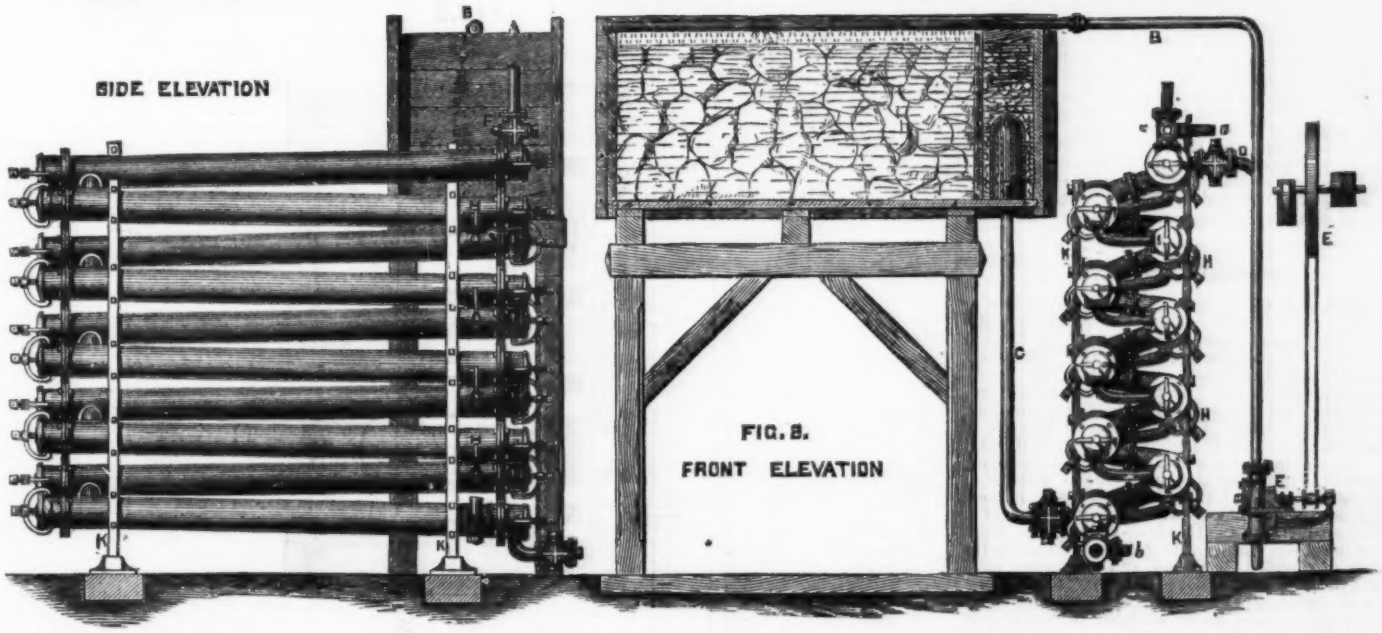


FIG. 8.

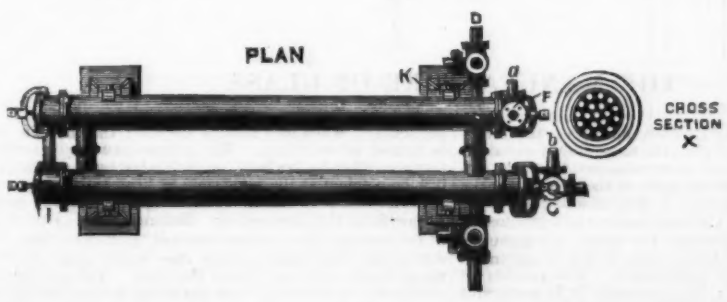


FIG. 9.

FIG. 10.

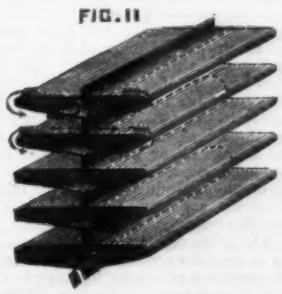


FIG. 11.

grinding are now integral parts of our system of milling. But there are some things which our mills yet lack, and to these we shall briefly allude.

We are not indulging in a platitude when we say our mills need more room. They need it, not only because our mills are too crowded and the fire risk too high in consequence, but they need it for the purpose of improved milling. Whatever may be thought of the future of our milling, this much is certain, that it is not going backward. Every elaboration of our present system of milling will call for more room in the mill. The more reductions are made, and the more elaborate the classification and grinding of middlings, the more grading reels, bolting surface, and purifying capacity will be required, and with these, more elevators, conveyors, and stock bins. The fact cannot be disguised that most mills, as they exist to-day, have not sufficient room to put in the machinery which it is probable will have to be put in before the lapse of any great length of time. While the room they now have may suffice or be made to answer for the present, every additional elaboration of our system of middlings milling will make a draft upon this room which can only be honored by unduly crowding the machinery.

Of course it is not possible to remedy these defects in most cases, and the old mill house must be made to accommodate the machinery which improved milling demands until an addition can be made to the mill. But much can be done, even in old mills, to *make* room. The old dust rooms can be torn out and built outside of the mill. The more flimsy the outside structure is, so long as it is damp proof, the better. Dust houses are not nearly so dangerous as insurance men attempt to make out, but they are a precautionary measure to place them outside of the mill, where, if an explosion takes place, it can do no harm; and that is why the lighter it is made the better. It can readily be seen that in a great many cases the removal of the dust house would supply room that is much needed for other purposes. So, too, the cleaning machinery of the mill is often placed where it occupies room that is needed for purifiers or reels. Where it is possible it is always best to clean the wheat in an outside building. This is now done in many new mills, and old mills that need storage capacity for wheat should by all means erect a small building near the mill, and clean the wheat in that. Power can easily be transmitted to such a building by wire rope. But where a new building cannot be erected for storing and cleaning the wheat the basement of the mill can often be made available for this purpose. Many mill basements are utilized only as a place for the driving mechanism, and are littered up with rubbish that might easily be removed, and the basement fitted up as a cleaning room. Here, also, wheat grading reels might be placed, and the undue pressure for space taken off of the upper stories, which should be used for purifying and bolting.

And this increased space for purifying and bolting capacity will all be needed some time. In the years to come, whatever our system of milling is, we will use more purifiers and more reels than we do at present. Elsewhere this month is reported the sale of one hundred purifiers for half of a single mill. These hundred machines are to take care of the middlings made by apparatus that will turn out in all 1,600 barrels of flour per day; but this millowner is one of the few that perceive the prime importance of having sufficient purifying capacity. The high grinding mills abroad have long since discovered that plenty of purifiers were essential to good results by their system. In the Gisela Steam Mill, which has just been started up at Budapest, there are eighty purifiers, the capacity of the mill being about 1,100 barrels per day. Of course our mills will not be obliged to greatly increase their purifying and reeling capacity all at once. As they become better acquainted with gradual reduction, they will discover points where they can use more grading reels and purifiers to advantage, and will put them in gradually, until they will look back and wonder how they ever got along with so few. And this will be well for the character of our milling. All our systems of gradual reduction would show better results if their work was only supplemented by more purifiers and more grading reels. Therefore we say that some of the needs of our mills are more room, more purifiers, and more reels. To these we may add what has been repeated in these columns before, that most of our mills are decidedly weak in their cleaning apparatus, not in the quality of it, but in the amount of it. Our millers should not forget that these are important things in any system of milling, and that while they may do creditable work with little cleaning machinery, few purifiers and reels, they can do vastly better work under any system with an abundance of cleansing and separating surface.—*American Miller.*

GLASS MANUFACTURE.

AT first sight there seems little analogy between iron or steel and glass, and one scarcely expects inventors of modes for working the former products of the earth to be next found improving the manufacture of so entirely opposite a compound as is that of the latter. And yet to one family at least the hostile properties of the two subjects seem to present no difficulty, and the scientific world has now long been accustomed to find the illustrious name of Siemens in connection with almost any important discovery of the day, no matter how varying the requisite research and study may be. The career of probably the most notable member of this family has lately been reviewed at some length in these pages. Our present notice deals with another member of it —Herr Frederic Siemens, of Dresden—whose latest work has been an invention dealing with "improvements in the manufacture of annealed, hardened, and toughened glass articles, and in the means employed therefor." The invention has more particularly for its object the enabling glass articles of irregular shape to be annealed, hardened, and toughened in the course of manufacture by special applications of processes and apparatus formerly invented.

In carrying out these processes it has been found that much more perfect results can be obtained by applying them to a glass plate or slab of uniform thickness than to glass articles of any other form by effecting the uniform cooling of such a plate after it has been uniformly heated only from the two parallel surfaces thereof. If the heating or cooling be applied also to the edges or circumferential surfaces, these and the parts nearest them will be sooner heated or cooled than the central parts, as the former present less surface to the heating or cooling influence than the latter. Unequal tensions or strains are thus produced in the glass body which frequently result in its spontaneous rupture; this result will also be produced if the cooling takes place more rapidly than is consistent with the conducting power of the glass. It is therefore necessary in order to effect the proper treatment of glass articles of irregular shape to place them as nearly as possible under the same conditions as a glass slab or plate of uniform thickness cooled at a suitably regulated rate only at its parallel faces. For this purpose such articles are arranged along with a material of approximately the same conductivity as glass, such as sand, or sand and clay, preferably burnt, so as to present a slab of uniform thickness, all the interstices or irregularities being filled up so that the rate of conduction throughout may be as nearly as possible uniform. An artificial plate or slab is thus produced of the character required, and having been uniformly heated its cooling is effected exclusively at its two parallel sides. The rate of cooling depends mostly on the thickness, that is, the thicker the plate the more slowly should it be cooled. The consecutive manipulations that are employed are as follows: 1. Preparation of the moulds for the glass body to be manufactured. 2. The introduction of the glue into such mould. 3. Uniform heating and production of the "ideal plate." 4. Cooling the same. In manufacturing the articles to be treated recourse is had to casting in much the same manner as in casting iron. The moulds for this purpose may be of iron, but generally it is preferable to use moulding sand mixed with the materials usually employed to give porosity, the moulds being dressed as usual on the surface, and thoroughly dried by baking. For undercut patterns and holes or vacuities cores are used as in iron moulding. The moulding box should correspond nearly to the shape of the article to be cast, so that there may be round it a nearly uniform thickness of sand in order to facilitate the subsequent uniform heating and cooling. The moulds may be filled from the tapping hole of a tank, or from a pot or ladle, or by running the molten glass from metal rods by which it has been taken up. In all cases, but particularly when iron moulds are used, the moulds should be heated before filling. The articles cast are heated in a furnace either by fire heat, or preferably by a gas flame, and it is convenient at the same time to heat the sand or other material that is to be employed along with them to make up the artificial slab for cooling. Before or during the heating of the castings all cores are removed, as if these were left in during the subsequent cooling they would give rise to unequal strains and consequent fractures. The castings when uniformly heated along with the filling-up material are made up into the artificial slab or plate form to be cooled, and in

FIG 1.

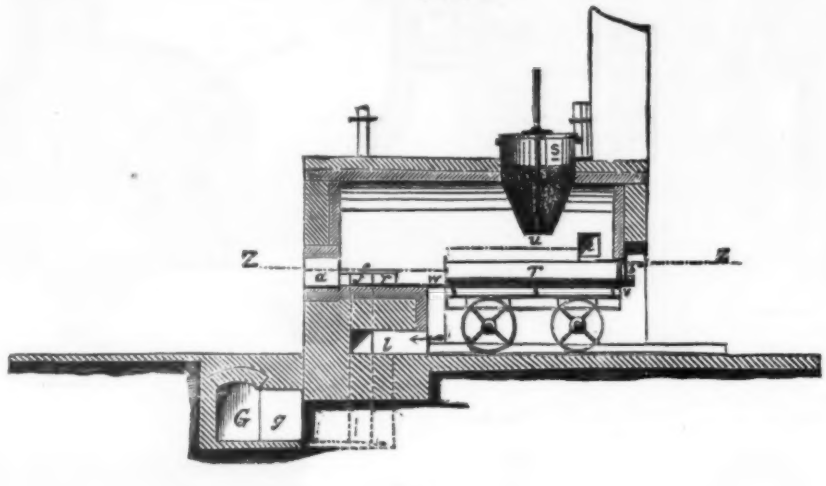


FIG.2

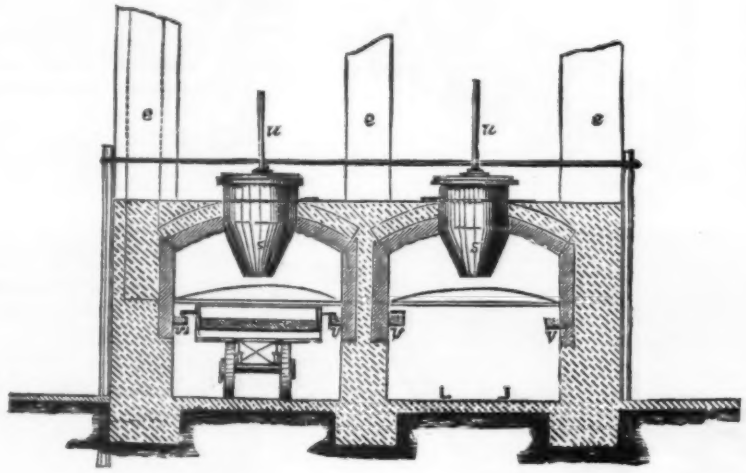
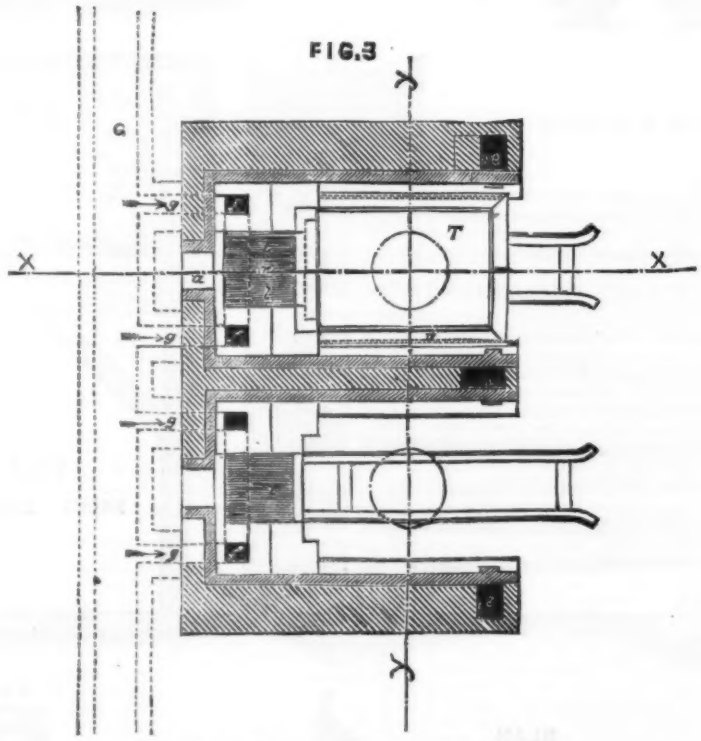


FIG.3



THE MANUFACTURE OF GLASS.

order that these parts of the process may be conveniently carried on, annealing trucks are employed. Such a truck, made with double-plated sides and single-plated bottom and cover, is brought to the heating oven, and having its bottom covered with a layer of heated sand, the glass articles are bedded in the sand layer; they are then covered by heated sand, care being taken that all interstices are filled, and the cover being put on, the truck is removed to be cooled. In many cases it is convenient to heat and cool the glass castings without removing them from their moulding boxes, and in such cases care must be taken that the box should nowhere touch the sides of the cooling truck, otherwise there would be inequality of conduction, and consequent irregularity in the cooling. For convenience of moving the articles into the truck, the heating oven is made with a recess into which the truck is wheeled, its bottom being on a level with the oven floor. Instead of a truck an iron box may be employed, but it is less convenient for moving, and as it has to be cooled uniformly on its lower as well as its upper surface it must be suspended or supported so as to expose its lower surface. The box or truck body charged with glass articles and filling-up material constitutes virtually the slab or plate of uniform thickness, protected around its circumference by the double plating, and exposed for cooling only on its parallel upper and lower surfaces. When the castings are of a simple and uniform character, the process may be somewhat simplified.

The accompanying drawings show the described mode of carrying out the invention wherein the heating and formation of the "ideal plate" are effected in one and the same oven, part of which is formed by the truck in which the cooling is afterward effected; this arrangement being more particularly applicable for the production of flooring plates, tiles, roof lights, and generally for articles of small and comparatively uniform height. For effecting a continuous working a pair of such ovens are required, of which the one is being heated while the other is in operation.

Fig. 1 shows a vertical longitudinal section of one oven on line X, X, Fig. 3; Fig. 2 shows a cross section of a pair of ovens on line Y, Y, Fig. 3; and Fig. 3 shows a sectional plan on line Z, Z, Fig. 1. The ovens are heated by gaseous fuel, the combustible gas being introduced through the main flue, G, and passages, *g*, and issuing through the ports, *f*, into the oven, the requisite air supply for combustion being also caused to enter through these ports from passages, *l*, into which it flows from beneath the bottom of the truck, indicated by the arrows. The products of combustion pass off through the chimneys, *c*. *a* is the working door, opposite to which is the leveling table, *r*, consisting of a planed cast-iron plate of suitable thickness to prevent warping. On to this table the glass slabs are placed direct from the casting moulds, and upon it they become uniformly heated to the requisite degree, and at the same time assume the perfectly level shape required. The truck, T, which forms the floor of the oven, is constructed of sheet iron, the bottom and front end, *w*, being single, and the latter being arranged to turn down, as shown at Fig. 1, while the back sides are made double with intervening air spaces. If the roof of the oven, about the middle of the truck, is fixed the sand magazine, S, from which the sand, heated to the same temperature as the oven, is caused to descend into the truck on opening the valve, *u*, by means of an external lever. The sides of the truck are provided with flanges dipping into sand troughs, *v*, for forming an air-tight joint with the sides of the oven, as shown; and the outer end of the truck has a sand trough, v^1, into which dips a removable plate, *b*, for the same purpose. The cover of the truck consists simply of a flanged plate, which is either fitted on after the truck has been removed from the oven, or it may be slid on through the narrow aperture in front after removal of the plate, *b*, before the truck is wheeled out. The trucks of both the ovens having in the first instance had a layer of sand placed in them, which is carefully leveled, they are run into the oven, and the hermetic sand joint is formed as described; also the sand is introduced into the magazine, S, and the whole is heated up to the required degree.

The glass articles having been cast are introduced as hot as practicable into one oven on to the table, *r*, which is large enough to receive several such articles, in order that they may be there heated to a uniform degree. The articles are then placed on the sand bed of the truck, and more of the articles are placed on the table, *r*, to be heated, and are afterward transferred in like manner to the truck. When the truck is filled with glass articles, the valve, *u*, is opened and the sand is allowed to flow down over the glass articles in such quantity as, when leveled down with a rake, to form a sufficiently thick layer over them. The cover is then placed on the truck, the front end, *w*, having been first turned up, and the truck is removed and placed aside to cool. A similar truck with its prepared sand bed is then introduced into the oven, and fresh sand is, if necessary, filled into the magazine, and the whole is heated up, while the before described operation of heating the glass articles and filling them into the truck is being carried out in the adjoining oven, which has been heated during the filling operation carried on in the other one.

The hinged side, *w*, being, for convenience sake, made single instead of double, as are the other sides, the greater conduction of heat at that side may be counteracted by placing an increased quantity of sand between it and the glass articles nearest to it. Also, as described, the cooling action of the current of air passing into the oven below the truck may be counteracted by introducing below the bottom of the truck a second bottom having a layer of sand, which second bottom is removed when the truck has received its charge.—*Universal Engineer.*

[THE BREWERS' GUARDIAN.]

THE USE OF RAW GRAIN.

At the recent Exhibition at the Agricultural Hall, samples of beer were shown made from mixtures of malt and raw grain, and from mixtures of malt and sugar prepared from maize. These samples attracted considerable attention, and no doubt many brewers will now try their hands at brewing from raw grain. There are two ways in which the farinaceous constituents of raw grain can be saccharified and rendered soluble: One is by dilute sulphuric acid, and the other is by malt extract. Visitors at the Agricultural Hall had the opportunity of tasting beers prepared by both methods, and will be able to draw comparisons as to their respective merits. The sulphuric acid method may be new in a brewery, but this system of conversion has been adopted for years past, only the process has been conducted by the glucose manufacturer instead of by the brewer. It is now proposed that the brewer should make his own glucose, and there are some advantages in this system, but also many disadvantages. Without going into the economy of the question, it must be borne in mind that raw grain, and especially maize, requires some special treatment before it is suited to the manufacture of beer. The husk of raw grain always contains certain constituents which impart a rank, bitter, and unpleasant flavor to the beer, the steeping process during malting removes these objectionable constituents, but when ordinary raw grain is used in brewing, they pass into the beer. The bad flavor of beers made from raw grain may be to some extent masked by extra hopping, but in case of mild beers this objection is fatal. The only way to obviate this difficulty is to remove the husk from the grain prior to mashing, and then we shall have left certain farinaceous constituents which are easily converted into sugar by either acids or malt extract, and which then possess no unpleasant flavor whatever. The solution of this problem rests more with the engineer than the chemist; what is required is the arrangement of suitable mechanical appliances for removing the husk from raw grain; if this can be successfully accomplished, a pure starch meal will be left which will be admirably adapted to the brewer's use, and will yield a beer equal in delicacy of flavor to that made solely from malt.

INFLUENCE OF COMPRESSED AIR ON FERMENTATION.

It is a well-known fact that compressed air is injurious, and even fatal, to both plants and animals. M. Paul Bert has investigated this matter, especially with reference to the influence of compressed air on the microscopic organisms which induce fermentation as well as on the soluble ferments. He found that certain minute plants and animals, which are developed during fermentation, are killed by the action of oxygen at very high tension, in the same way as are living beings of larger size and more complex structure. Beer yeast and diastase, however, retain their properties when submitted to the action of compressed air, no matter how intense the pressure, or how long prolonged; but the conversion of starch into glucose takes place in compressed air with less activity than at the normal pressure. When a diastasic ferment has been submitted to compressed air for some days, and then placed in a flask, which is subsequently hermetically sealed, it retains its properties for an indefinite period, on the other hand, at the normal pressure it is attacked by fungi, and soon loses its chemical energy. These researches have an important bearing on the preservation of beer, and we shall refer to them at greater detail on a future occasion.

PRODUCTION OF MALTOSE.

The most favorable temperature for the production of maltose is, according to Schultze, 60° C. (140° F.), and the production diminishes with increase of temperature; thus 100 parts mashed at

62° C. (143·6° F.)	yield	78·64	maltose.
65 " (149° F.)	"	70·28	"
70 " (158° F.)	"	62·72	"
75 " (167° F.)	"	59·73	"

The same investigator differs from Mulder and others as to the proper amount of mashing liquor, for he considers the yield of maltose is not injuriously affected by increased proportions of water; he obtained the same results with from 4 to 8 parts of water to 1 of malt. His experiments as to the length of time to be given to the mashing prove that a slow working from the commencement to the sugar temperature yields more extract and more maltose than rapid working. He has further considered all the circumstances which exert an influence on the extract and maltose, and also as to the respective merits of the infusion and decoction methods; his results may be summed up by stating that both methods possess advantages and disadvantages peculiar to themselves, which the brewer must choose between according to his requirements.

MOISTURE IN MALT.

The same investigator has determined the amount of moisture in barley and malt at the various stages of its manufacture. The method adopted was to cut the grain lengthwise once and crosswise four times with a pair of fine scissors, and then to dry the fragments in watch glasses in an air bath heated to 100° to 105° C. (212° to 221° F.) and afterward to cool them over sulphuric acid. The following results were the mean of six experiments:

Raw barley	14·9	per cent.	of moisture.
Steeped barley	40·3	"	"
Raw malt	39·9	"	"
Malt after 8 hours' drying on the upper floor of a double kiln	6·5	"	"
Malt after 8 hours' drying on the lower floor with the plumula	1·7	"	"
Malt after 8 hours' drying an the lower floor without the plumula,	1·6	"	"

ANALYSIS OF SPEYER BEER.

The following analyses of this well-known beer are by Halenke:

	Summer Beer.	Winter Beer.
Specific gravity	1·018	1·018
Alcohol by weight, per cent.	4·4	3·9
" " volume "	5·5	4·9
Extract "	7·30	6·92
Ash "	0 25	0·25
Water "	88·74	89·18
Original gravity "	15·30	14·57
Degree of fermentation	55·2	52

TREATMENT OF NEW CASKS.

New wood yields an extractive matter which imparts an unpleasant flavor to beer, and it is therefore advisable to submit new casks to some kind of "sweetening" treatment. For this purpose many substances have been recommended, but as the extractive matter is no doubt of an astringent nature and possesses slightly acid properties, an alkaline liquid is the proper remedy. E. Bibra, in the *Journal für Praktische Chemie*, recommends the following method: One pound of soda crystals is used for every 10 gallons of the capacity of the cask, and this is dissolved in a small quantity of soft water; the cask is two-thirds filled with soft water, and then the requisite quantity of soda solution added; after thorough agitation the cask is completely filled with water and bunged down; after standing for ten or twelve days the alkaline liquid is run away, and the casks rinsed several times with water. The author found that by this treatment the staves were completely exhausted of all extractive matter to a depth of about a quarter of an inch, and beer or wine might at once be placed in such casks without fear of being contaminated with any objectionable flavor.

PORCELAIN PHOTOGRAPHY.

By J. R. Sawyer.

In the very heart of Old England, in the midst of her most lovely charms, upon ground of historic interest, from the time of the Romans downwards, in the near neighborhood of places whose names recall the most stirring events of English history, rises a grand chain of hills, dividing Worcestershire from Herefordshire; on the south, the Herefordshire Beacon, crowned with the boldly drawn lines of the ancient British camp of Caractacus, dominates the vast and fertile plain extending for miles and miles into the far distance; on the north, the Worcestershire Beacon rises high above the beauties of Great Malvern, which nestles at its feet, or aspires to climb its bold flanks.

O for the old days! "O for the time twixt now and then," when with youth, health, and strength, we breasted those hills, laughed to scorn those zigzags, up which then, as now, quiet people leisurely ascended on the backs of equally leisurely donkeys, little thinking, or, if thinking, caring nothing, as to the days when we, too, should bless the convenient and admirable paths by which the wise ones of Great Malvern have contrived to tempt their visitors to the top of one of the finest range of hills in the world.

Once on pony back upon the ridge itself, with a fine day, a delicious west wind, a cloud-flecked firmament, what a sensation! We never were "up in a balloon," but this must be very like it. The ground falls away on either side, leaving you on a sort of backbone, with a sensation of being suspended in air, with a vast horizon on every side; and what a view! On the Herefordshire side what lovely sylvan beauty of hill and dale! Towns and villages nestling in the most luxurious of woody landscape. In middle distance, Gloucester with its cathedral; Tewkesbury with its abbey and grand historical associations; afar off the Welsh mountains, with clouds resting upon them; a streak of silver, as far as the eye can reach, is the Bristol Channel, sixty miles away. Then turning northward, the eye ranges over a vast plain, the valley of the Severn, rich in fat meadows and luxuriant cornfields, bounded by the hills dominating the vale of the White Horse. Eastward, Malvern itself nestles at the foot of the grand Worcestershire Beacon, and over that shines the tower of Worcester Cathedral, standing up distinct and clear amidst the group of houses and factories which cluster round it.

So let us clamber to the roof of the well-appointed four-horse coach, and by the loveliest highways and byways we, in an hour and a-half, clatter up Foregate Street to the Cross, and are in the midst of the quaint old city, with its old-fashioned houses, picturesque roofs, and narrow streets. Worcester is the seat of the celebrated Royal Porcelain Works, which for the last 150 years have turned out some of the most delicate and artistic of English work in porcelain; it is called "Royal" because George the Third, visiting the works in 1788, granted his warrant permitting the establishment to be so designated, and well deserves its name, not only on account of the superb works of art produced in the ateliers, but also for the right royal hospitality with which it receives visitors, and permits them to view the interesting series of operations involved in the production of the higher branches of ceramic art.

In an article upon ceramic photography it might scarcely be thought necessary to touch upon the manufacture of the porcelain itself; and so long as photography is content to produce pictures upon enamels specially made and of comparatively small size, it would seem to be quite superfluous; but when it becomes a question of employing photography as a decorative art, and to apply it to porcelain, it is absolutely necessary that the operator should have some knowledge of the substance he is working with, the manner in which it is glazed, and the colors he proposes to employ to this end. Therefore the reader will be introduced to the various stages of porcelain manufacture with a view to arriving at a competent knowledge of the subject in an enlarged and commercial sense.

The materials of which Worcester porcelain is composed are not found in the locality in which the manufactory is situated, so that the trade cannot be said to be indigenous. Doubtless, in former years, considerable difficulty was experienced in obtaining the necessary materials; and it was not until Brindley opened out the district by his system of canal navigation, and later on, George Stephenson, with his iron road, made facilities for transit unknown before, that the Worcester porcelain became important commercially as well as artistically.

The visitor who joins a party of four or five, in the waiting room, having the same object in view as himself, is conducted, first of all, to the room in which the materials are ground. The mills are vast tubs, paved with a very hard stone called chert; in the middle revolves a vertical shaft, attached to which are four strong arms, carrying circular stones which, when the machinery is in motion, travel round the inside of the tub, and thoroughly crush up and disintegrate the material placed therein.

The principal ingredients of porcelain are china clay or kaolin, petuntse (which is a decomposed granite rock found in Cornwall) feldspar from Sweden, and calcined bones. The use of the latter article makes the chief difference between English and Continental porcelain, the former being known as soft, the latter as hard, porcelain. These ingredients having been placed in the tubs with a sufficient quantity of water, the machinery is put in motion, the ponderous stones begin to revolve, and the grinding goes steadily on, sometimes for days, until the whole is ground into a grayish looking soup. The materials having been thus separately ground, now pass into what is called the slip house, and the various ingredients comprising the porcelain are here mixed together, being stirred up by machinery having radiating arms fixed on a vertical shaft. These arms are provided with powerful magnets, and as they move through the fluid the particles of iron which may have been present in the raw material, or may be the result of abrasion of the machinery, are attracted by these magnets, and are thus prevented from sullying the delicate print of the porcelain by their presence.

The material, which is designated *slip*, now passes through a series of sieves of exceedingly fine silk lawn, which allow nothing but the perfectly ground mixture to pass, keeping back all the coarser particles. The next process is to get rid of the surplus water, to which end the slip is pumped

into what is called the clay press, a machine with a number of chambers lined with linen bags; the slip is subjected to hydraulic pressure, until sufficient of the water is squeezed away to cause it to assume the consistency of dough.

The dough is next taken to a vault called the clay cellar, and is there subjected to a most complete kneading, with a view to giving it consistency and toughness; this is the material used in the actual manufacture of porcelain; to the eye it is a grayish-looking mass, the particles composing it being of exceeding fineness; to the touch it gives the idea of great toughness and tenacity.

The ancient method of making circular vessels was by means of the potter's wheel, perhaps the most ancient mechanical contrivance of which any record has been preserved. At the Worcester Porcelain Works this mode of making cups and basins is shown greatly to the gratification of visitors, although the process is not used for business purposes. It is very interesting to see the potter take the lump of clay, which has been previously carefully weighed by his assistant, throw it on his wheel, which revolves horizontally, then with deft and practiced fingers, fashion and mould it, and presently there comes up, under his skillful hands, the most delicate and elegant form in the plastic material; to this he affixes a handle, which has been pressed in a mould, merely using a little of the fluid slip, which forms a most powerful junction between the two.

Most of the articles manufactured in porcelain are made in moulds, and the visitor notes with some surprise the large size of the familiar objects; this is to allow for the shrinking in the firing; the pressed and moulded articles are stored in a drying-room, preparatory to being placed in the gigantic kiln, where they will be exposed for hours to an enormous heat.

The kiln has the appearance of a circular room dome-shaped, the center going up into a sort of wide chimney; this is about fourteen feet in diameter, and has six or eight furnaces arranged at intervals round it. It is built with fire brick, and encircled with strong iron bands. The entrance is by a doorway, and the articles to be fired are placed in the kiln in what are called seggars, which are cases made of fireclay, and of shapes suitable for the various articles to be placed in them. Each large piece has its own particular seggars, in which it is carefully placed, embedded in calcined flint. The smaller articles are placed several together, but always embedded in the powdered flint, and properly supported to prevent them getting out of shape.

The seggars being filled with the ware are now placed in the kiln, piled one above another in the most careful manner; the proper placing and filling up of a kiln, containing, perhaps, many thousand pieces of valuable ware, being a work requiring great skill and experience. As soon as the kiln is full, the doorway is bricked up, the great furnaces are lighted, and for forty hours are kept going. The kiln becomes heated, then red-hot, then at a white heat; when the whole interior seems to be a mass of incandescent fusion. On looking through one of the small trial holes, the eye sees nothing but a blinding white heat, which strikes through the hole through which you have been peering, with most unmistakable power. This terrific heat is kept up for some forty hours or so; then the kiln takes forty-eight hours to cool. The doorway is broken open, and the articles inside have become the delicate and fragile porcelain known as biscuit ware.

The effect of the enormous heat to which the porcelain has been subjected for so long a period has been to drive off every particle of moisture contained in the forms, which, by shrinking, now present themselves as having the accustomed sizes and shapes; the action of the intense heat has also fused the various materials composing the dough or tenacious clay, out of which the articles have been pressed or moulded, into a vitreous and transparent substance, known as biscuit porcelain.

The biscuit ware of Worcester is of a most lovely purity of color; not a trace of the gray tone observable in the clay state remains, but a pure unsullied white characterizes the pieces. The next step is to cover the absorbent ware with a non-absorbent film or glaze. It would appear that the biscuit stage of the manufacture would be the most suitable, photographically considered, for applying the decoration, but as a matter of fact, at present, the skill of the decorator is not brought into requisition until a later period, when the ware has received its glaze.

The various pieces having been carefully taken from the seggars, and the powdered flint dusted from them, are carefully looked over, and all faulty specimens are put aside to be disposed of as wasters, and it is singular for what a very slight cause a piece is rejected. In most of the towns in the neighborhood are earthenware shops where most lovely specimens, so slightly imperfect that their faults are non-apparent to the uninitiated, may be purchased for a few pence.

The perfect pieces are now taken to the dipping-room. Here the visitor sees large tubs filled with a creamy-looking fluid. At these tubs stand men, who take the biscuit ware, and, holding it with a dexterity acquired by practice, dip each piece in the fluid in such a manner that the glaze shall be perfectly distributed over the surface; this is so cleverly managed that there is no trace on the finished article of the points where the articles have been held. From the dipping-room they are next taken to the drying stone, the heat of which rapidly dries the glaze.

The dipped ware now goes into the trimming-room, where it is carefully examined by women, who mend up any imperfect places, and otherwise make it perfect for the next operation, which is the firing, for the purpose of melting the glaze and causing it to cover the porcelain with that delicate bright enamel surface so characteristic of the Worcester manufacture. In the photographic decoration of porcelain the glaze has to be specially considered, as will be manifest when the mode of doing this has to be described. The glazes are of different degrees of hardness, varying with the practice of different manufacturers, and even with the different kinds of work turned out. Glaze is composed mainly of borax, calcined flints, and red lead, which, when fused by heat upon the surface of the porcelain, form a sort of glass. There is much secrecy about the composition of glazes, but the most easily fusible are said to contain more lead, while the most refractory contain a larger proportion of calcined flint. It will be seen presently, that in the application of photography to the decoration of porcelain, it is almost impossible to use any but the pure color, and to depend upon the fusing of the glaze already upon the ware for the burning in and glazing of the photograph; consequently a glaze that fuses at a comparatively low temperature should always be sought for. As the potter and the photographer have scarcely as yet begun to work in alliance with each other, this is a matter that at present causes difficulties which, when better understood, may not arise.

To return to the dipped ware; it has been dried, examined, and the perfect pieces are now ready for what is called the "glost oven;" this is in reality a kiln very much like the one previously described, and in which the pieces are placed separately, and with the utmost care; the most extreme cleanliness is here a necessity, as particles of dust, or any foreign matter in fact, would settle upon the ware and spoil the result.

The pieces being all placed and the oven filled, the doorway is bricked up, the furnaces lighted. The whole is rendered incandescent by intense heat, and the operation is completed in about thirty-six hours; at the expiration of this time the oven has probably cooled sufficiently to enable the porcelain to be removed, and it comes out perfectly glazed of a beautiful white color, and is now ready to be decorated by the painter and gilder, and is in the state in which, for the present at any rate, it is available for the purposes of the photographer.

In the decoration of porcelain, two distinct kinds of color are employed, named respectively under-glaze and over-glaze colors; the former being supposed to be the oxides of various metals without addition, or with but a small addition, of the easily fusible substance known as flux, the latter being similar oxides with a considerable addition of this material. The writer of this article has no actual knowledge of this branch of the business except what he has derived from his own experiments and observations, for the manufacture of porcelain colors is a trade in which the secrets are guarded with the most jealous care; the various makers are perpetually striving to out-do each other, and if a color is invented of a new shade, or of a superior brilliancy, the mode of its production is kept absolutely secret.

Fortunately, the decorative photographer needs only to work in monochrome, and provided he can obtain, or prepare, black, red, and blue, and manage to make them fuse at the same temperature, he has got over an initial difficulty, but it is a difficulty. Suppose that the red vaporizes before the black is glazed, it simply flies off and leaves a cold black, where a rich warm brown is desired; doubtless if the demand should ever become considerable, and the porcelain color makers find it worth their while to understand the conditions of photographic decoration as applied to porcelain, the way will be immensely smoothed, but at present it is beset with pitfalls and difficulties in this direction. Assuming that a satisfactory color has been obtained, the next question is how to apply it to the smooth, shining, and perfect surface presented by the porcelain. One method of doing this, and which has been already practiced to some extent, is by the powder process. There are three formulæ given in Mr. Solomon's little work on Vitrified Photographs on Enamel, for a sensitive hygroscopic compound, which, when poured upon glass and exposed to light under a positive transparency, is hardened where the light penetrates, and becomes more or less susceptible to moisture according to the strength of the actinic rays acting through the various degrees of density in the transparency; one of these compounds, composed (say) of dextrine, grape sugar, and gum-arabic, sensitized by bichromate of ammonia, is poured upon a clean glass plate and allowed to dry in the dark; when perfectly dry, this is exposed under a transparent positive in a printing frame to the action of the light; when sufficiently exposed, it is taken into a room lighted by yellow light, and the oxide color, ground to an impalpable powder, is dusted upon the plate; as the film attracts moisture gradually from the atmosphere the color begins to adhere to the deep shadows, and finally the picture is developed in a color that can be burned into porcelain or earthenware.

The picture, having been developed, is coated with a thick collodion, which, when dry, holds the picture thoroughly, the bichromate is removed by immersion in weak nitric or muriatic acid, which floats off the film from the glass, and it is now ready for the delicate operation of transferring to the piece of which it is destined to form a portion as indestructible as the porcelain itself.

The methods of applying photographs to enamels or porcelain by means of the powder and substitution processes, although fairly adapted to small work, and as a foundation for color or monochrome finish, can scarcely be considered as more than the basis for after treatment; but it seems strange that, with the varieties of oxide color at the disposal of the operator, greater variety and perfection of result has not been hitherto obtained. It would appear that, if a practical application of photography on a large and commercial scale be desirable, it must be sought for in the direction of a process analogous to the carbon, or, more properly, the pigment processes known as autotype.

There are certain conditions peculiar to the nature of the work, which all experimenters in this direction well know cannot be overlooked. In the first place, colors with a large amount of flux are quite inadmissible, as although it is possible to mix them into gelatine or a similar vehicle, the amount of lead in the flux will interfere in a most remarkable manner with the sensibility of the tissue, by combining with the chromic acid, and forming a chromate of lead, at the same time making a yellow stain on the material when it is fired. There is also another difficulty; the pigment is diluted, so to speak, by the flux, and gives a poor, weak image, instead of a bold and vigorous one. But, it will be asked, why employ a color with flux in it at all? For this reason: that if a pure color is employed, it is necessary to raise the temperature of the porcelain in firing to a heat sufficient to fuse or melt the glaze of the porcelain itself, and, in melting, incorporate the color into the original glaze, while the fluxed color melts at a much lower and more convenient heat, and is fused on the top of the original glaze.

It will now be understood what is meant by under glaze and over glaze colors; the former having to be incorporated with the glaze already on the ware, by means of a heat at least as great as that of the "glost oven" previously described; the latter being fused upon the glaze at a much lower temperature, on account of the easily fusible material with which the color is mixed; but this material, unfortunately, interferes with the success of the operations, by making the tissue insensitive to the action of the light, and, if this is overcome, as it may be, by immersing a second time in the bichromate solution, then by giving a poor, weak image, instead of a bold and vigorous one.

Thus it comes about that colors as nearly pure as possible must be employed to secure success in any efforts in the direction of printing by means of pigmented tissue upon porcelain. But then crops up this other difficulty: the firing—or, rather, the fusing—point of different colors, such as black, red, blue, are by no means the same, and they can only be brought into agreement by the admixture of some material—the flux, in fact—that gives way at a lower temperature.

The best plan to pursue until experience has been gained, is to take some simple colors, such as black, brown, blue, and red, being careful that they are what are called under glaze colors; these are sold by the ceramic color makers in the form of fine powder. Take a little of each of the colors, and rub them up separately with a glass muller and a little fat oil of turpentine; now take a small piece of the porcelain upon which it is proposed to operate; make a rubbing of the colors, and have it fired; this preliminary experiment will give an idea what shade the colors will be when fired, and how far they agree or differ as to the temperature to which they must go.

Having settled upon the color, the next thing is to get it into gelatine; but gelatine is an awkward substance to manipulate, as, if it is in sufficient quantity to hold the heavy color, it will be very likely to "frizzle" on the porcelain when it begins to feel the heat. This frizzling is a great nuisance; it means the entire ruin of the picture, for as soon as the heat of the muffle begins to tell upon the plaque, the gelatine contracts, bursts up, and brings picture and all with it.

The hard, strong gelatines seem to be useless in this respect; but the weaker forms—such as the soup gelatine of Cox, and the weaker sorts of Nelson—promise most hopefully. Having selected the gelatine, make a solution of 25 per cent., adding to this about 10 per cent. of white sugar. Now, with a slab and marble muller, grind up the color selected, in water, to the finest possible state of division. The quantity of color to be added to the gelatine must be determined by experiment, as it will vary with the strength of the color and the strength of the gelatine into which it is to be put. The color itself being heavy, it will not be possible to get any very large quantity into the rather weak gelatine that must necessarily be employed. The color, being well ground, must now be stirred into the warm gelatine, and if some arrangement can be made for agitating or churning it vigorously for an hour or more, the result is more likely to be successful. The gelatine and color must now be strained, and, after standing some little time, will be ready for use. To make the tissue, procure some pieces of plate glass, cut some sheets of Rive paper a little smaller than the glasses, damp them thoroughly, blot them off, and lay them down upon the glasses, smoothing out the creases, and attach them round the edge with a little gum; when dry, pour upon them sufficient of the prepared gelatine to give a thickness of about one-eighth of an inch, having previously leveled them carefully. When the gelatine is set, they may be reared up to dry, and, when dry, they will be ready for sensitizing.

To make the tissue sensitive, put into a tin dish a little larger than the sheets a five per cent. solution of bichromate of potash, and immerse each sheet for about three minutes in summer, and five minutes in winter. These should be treated very carefully to avoid air bubbles. The sheets should be hung up in a room made dark, or illuminated with non-actinic light, and, when dry, should be taken down, and kept from light and atmosphere in a tin case.

The printing must be conducted in exactly the same manner as ordinary carbon printing, and with the aid of an actinometer. The pictures must be printed very deeply, and if the negative is at all hard, a little exposure of the print to daylight (say from four or five seconds) after the sheet is taken from the printing frame will improve it, by conferring a certain amount of softness. If the print is from a reversed negative, it may be laid down direct upon the surface which it is proposed to decorate, and, in that case, no substratum will be necessary. If the print is from an ordinary negative, it must be developed in the first instance upon a provisional or temporary support.

As the porcelain has frequently a curved surface, and even a plaque or tile has an uneven surface, it necessarily follows that the temporary support must be flexible. There are two kinds open to the experimentalist, viz., the India-rubber paper of Mr. Swan, and the flexible support introduced by the author. At the Autotype Works the latter alone is used, as it answers the purpose, and is much more simple and economical than any other kind. Pieces of flexible support a little larger than the pictures are rubbed over with the proper waxing compound; this is applied with a light circular sweep of the hand, as if the object were to polish the surface of the support, in the same way that a French polisher treats the articles he manipulates. The sheets are laid aside for the spirit to evaporate, and are then ready for use. The printed tissue is placed in clean and very cold water, and, as soon as it is softened, its surface is brought into contact with the polished surface of the support. Both sheets being under water, they are lifted together, and absolute contact secured by a few strokes of the squeegee; they are allowed to rest a few minutes, then placed in warm water, the tissue paper skimmed off, and the picture very carefully developed. Considerable care is necessary in this part of the process, as the gelatine employed, being necessarily weak, the color will be so loosely held as to be easily washed away if the water be too warm, or the action of development too vigorous. The picture, being developed, should have a much darker appearance than is desired in the finished work; if not, it will burn away to a mere shadow.

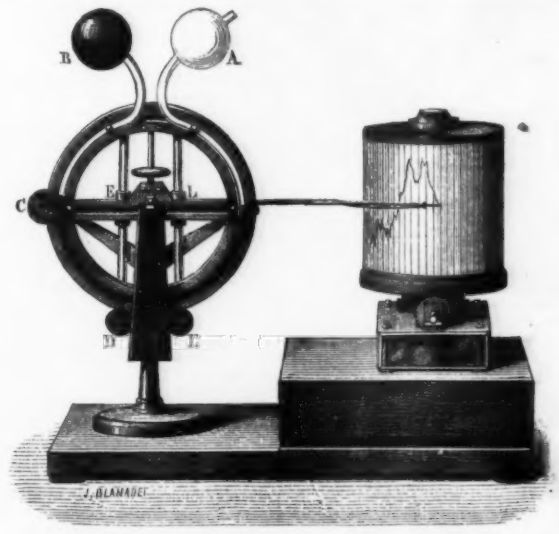
The picture developed upon the temporary support should be allowed to dry before transferring it to the surface upon which it is proposed to finally place it; when dry, the picture on the support is immersed with the plaque, tile, or piece of ware, upon which it is to finally rest, in a solution of gelatine, to which sufficient chrome alum has been added to slightly thicken it; the two are squeezed together, and, when dry, the support will leave the picture firmly attached to the porcelain. Pictures printed from reversed negatives can be put down at once on the surface to be decorated, and developed at once upon it.

The next question, of course, is the firing or burning-in, but this is a matter which nothing but the practical skill of the potter can effect successfully; it must be done in a regularly constructed fire clay muffle or kiln, heated by a furnace which will raise the whole to something like a white heat, so as to remelt the original glaze of the ware, and, in doing so, put the photograph under the glaze.

This branch of the photographic art is at the present moment quite in its infancy; if a demand arises, facilities will doubtless appear to enable the potter and the photographer to work together; and probably the reproduction of original designs, too elaborate to be done cheaply by hand, might be made a new development of photographic business. The best way to overcome difficulties is first of all to know clearly what they are. The author of these articles has painfully worked his way to some small measure of success; but this success depends so greatly upon the experience acquired by careful observation of results, that it is next to impossible to do more than indicate the rocks ahead, and to save other experimentalists some amount of shipwreck.—*Photographic News.*

THE RADIOGRAPH.

IN the SCIENTIFIC AMERICAN of May 29, of the present year, we figured and described an apparatus for registering solar radiation, the invention of an English physicist, Mr. David Winstanley. That apparatus has recently undergone an entire transformation at the hands of its inventor, and now appears under a form much completer, and one which it would seem must resolve in a very perfect manner an important problem worthy the attention of meteorologists. Mr. Winstanley's new radiograph consists of an air thermometer, having its tube bent into a circle, so as to bring the two bulbs in proximity to each other, as shown in the annexed figure. One bulb, B, is coated with lampblack, while the other is left transparent; the tube is partially filled with mercury. This air thermometer is fastened to a circular copper support which pivots on a steel knife blade, so as to oscillate like the beam of a balance. To the copper supporting-ring is fitted a lever arm, carrying at its extremity a fine tracing point, which touches a cylinder revolving by means of clockwork. Rolled around this cylinder is a strip of paper covered with a thin film of lampblack. The disk, C, represented in the engraving serves as a counterpoise to the tracing point. The other disks, D and E, are movable



A NEW RADIOGRAPH.

on the rods to which they are fitted, and are designed for raising or depressing the center of gravity of the whole as may be desired. The apparatus is inclosed in a copper case, and the glass bulbs, A and B, are covered with a bell glass exposed to the open air. The operation of the radiograph is as follows: Supposing the apparatus evenly balanced, and the bulbs exposed to the air, when the sun begins to shine the heat absorbed by the blackened bulb expands the, air contained in it, and thus drives the mercury up toward the transparent bulb. The result is that the apparatus turns on its pivot toward the right, causing a downward movement of the tracing point—the amount of such depression of the point being proportional to the degree of solar radiation. When the radiation becomes feeble or nil, the action of the apparatus is just the reverse. These various movements of the lever arm and point are of course inscribed on the sheet of blackened paper as it slowly and regularly revolves. This new apparatus, which is now being used at Kew, is said to be exceedingly sensitive; whenever the smallest cloud obscures but for an instant the solar rays, the fact is immediately recorded graphically on the paper.

THE MEASUREMENT OF HIGH TEMPERATURES AND NEW PYROMETRIC INSTRUMENTS.*

THE exact measurement of high degrees of temperature has a great importance for the exact sciences and also for their application. For this reason physicists have, with indefatigable zeal, tried to find a solution to this problem, and have ever been ready with suggestions whenever new discoveries in the various branches of science have seemed to open a way which might lead to the desired result. These suggestions have not been made in vain, but have led to a remarkable progress in the construction of our pyrometric instruments. A few years ago none but the mercury thermometers were employed for exact measurements, while for the determination of higher temperatures, the imperfect instruments of Wedgwood, Brongniart, Prinsep, etc., had to be used. Pouillet, as far as I know, was the first to use the air thermometer for pyrometric measurements. This instrument was afterward perfected more and more and made more and more useful by the labors of Regnault, Jolly, Hervè-Mangon, H. Saint-Claire Deville, and others, while to Codazza is due its employment for industrial purposes. Mr. Siemens, for the same purpose, constructed his pyrometer, the idea of which is based upon the variations of electric resistance offered by a platina wire according to the changes of its relative temperatures, and Rosetti, by an ingenious use of the thermo-electric currents, succeeded, finally, in measuring the temperature of the different parts of a flame. The results obtained by Rosetti, which confirmed the conclusions derived as a natural consequence from the phenomena of dissociation, were in full accordance with the discoveries of Draper, Saint-Claire Deville, and Bunsen, and they showed how much the temperature of a flame had been hitherto exaggerated. At present the optic method of Mr. Crova (*Annales de Chimie et de Physique*, April, 1880), is employed for pyrometric purposes. And although it will not be possible to give an exact description of this method in the columns of a weekly paper, we will, at least, mention its most important features. The idea of bringing the luminous appearance of a body into connection with its temperature is not a new one. The proprietors as well as the laborers of manufactories of lime and cement and also of foundries are able to tell only by looking at its appearance whether the product has the desired temperature or not, but by this means an exact measurement of the degrees of temperature had not been hitherto accomplished. Pouillet tried to establish a pyrometric scale in connection with the ordinary thermometric scale by noting down on the scale of his air-thermometer the temperatures which are indicated by the gradual change of color which is represented by a platina wire heated to a high temperature (red, cherry-red, whitish-red, white). The table compiled by him for this purpose is contained in nearly all treatises on physics. The exactitude of this table is not very great. For the practical measurement of the heat of a furnace, this scale of the heated platina wire would be perfectly valueless, and above all Pouillet's air pyrometer, with its platina, gave no security that the gases in the apparatus would remain unaltered as to quantity and composition; besides, it is extremely difficult to give a correct opinion of a color in the presence of so many other lights and in the presence of a thousand reflected rays, which latter can scarcely be avoided. A grave reason for suspecting the correctness of Pouillet's is the fact that the change of color always appears, according to his observations, at every 100 degrees; such extraordinary regularity always justifies doubt.

Spectroscopic experiments have recently shown that all bodies become luminous at the same temperature, while below this temperature they emit dark rays which become more and more intense according as the heat increases. At a certain temperature the deep-red radiations begin, and by and by, during a continued increase of temperature they are joined by those of higher refraction; the former, meanwhile, does not disappear, but continues to grow stronger.

This lasts while the light emitted by the body becomes more and more vivid, containing all the rays perceptible to the eye, until finally a brilliant, dazzling white light is produced. Draper, who has made a special study of these phenomena, found that the deep-red color of a heated body corresponds to 525° C. (977° F.), that the azure color corresponds to 700° C. (1,292° F.), and that the spectral-line, H, is seen at a temperature of 1,160° C. (2,110° F.)

These results, and the law of Jamin and Masson, which establishes the fact that strict proportionality exists between the thermic and luminous intensity of rays, led Mr. Crova to the idea of using the spectrum of a heated body for the purpose of pyrometric measurements.

Mr. Crova used for his experiments a spectrophotometer, similar to that of Glan. By the spectral apparatus of this kind of photometer the specters of two different luminous bodies may be observed simultaneously. A slight deviation from the usual construction is the situation of the prism which is placed transversely before the fissure, so as to permit the rays of a Berzelius lamp with a straight glass chimney to transpierce the prism and at the same time to permit the rays of an incandescent body to enter through the free part of the fissure. The telescope with which the magnified spectrum is observed lies in its focal plain a straight fissure parallel to that of the spectral apparatus proper, and through this the two spectral bands, which correspond to rays of a certain refraction, can be plainly seen when the telescope is properly inclined toward the axis of the spectroscope. If from the beginning the tube of the telescope is so directed that the red extremity of both spectra is visible, then by a careful regulation of the lamp an equal intensity of the light can be quickly produced, and by a slight movement of the tube in an opposite direction, the green end of the spectral bands can be brought into the field of vision. Their intensity is also easily regulated by means of tooth wheels, the movement of which is automatically registered and indicates the angle at which the rays had to be changed. From this angle is deduced, according to the well-known laws of polarized light, the relation between the quantity of green rays contained in the spectra of the incandescent body and that of the flame, after having previously equalized the intensity of the red radiations. This relation, which can be read from the scale, gives the means for measuring the temperature of an incandescent body.

But the degrees of temperature indicated by this method are optical degrees, and have nothing in common with the partition of our thermometric scales. Mr. Crova is trying to establish a connection between the optical and the thermometrical scale by comparing in the indicated manner the spectrum of the flame with that of the porcelain coop of a nitrogen pyrometer of perfect construction, analogous to the air pyrometer of Regnault, and by measuring the temperatures corresponding to these spectra by means of the manometer. Although Mr. Crova has not yet arrived at any final result concerning them there is a great probability that his experiments will be accompanied by a perfect success, and his investigations, if completed, will have led to the construction of a new instrument by which our knowledge of high temperatures will be remarkably increased. This instrument will be also of the greatest value for the industrial sciences, because by means of it even the highest temperatures, the knowledge of which has a practical importance, will be easily determined.

* Extract of an article by Professor Ferrini, of Florence.

ULTRA-NEPTUNIAN PLANETS.

A STATEMENT of the nature of the problem which Adams and Leverrier solved, in the computation of the position of the planet Neptune, will show why it is not now feasible to apply the same method to determine the existence of an ultra-Neptunian member of the system.

Uranus was discovered in 1781 by Sir Wm. Herschel. While examining the stars in the constellation Gemini, he noticed one of peculiar color and a planetary disk, and which subsequent observations showed to have a motion of its own among the neighboring stars. Numerous measurements of its position were taken, and from the most reliable of these the elements of its orbit were approximately calculated. Its position at definite times in the future was then ascertained from these elements, and the difference between these positions and the observed ones furnished data for a correction of the orbit. The effect of the attraction of the great bulks of Jupiter and Saturn was also taken into account

As Uranus requires eighty-four years to revolve about the sun, its apparent motion in a short time is very slight, and its orbit of very small curvature. Many years would therefore have elapsed before any irregularities could have been found had not old measurements, running back as far as 1690, been found, which, though taken under the supposition that it was a star, were now available to compare with the theoretical orbit. Some discrepancies found caused a new computation, and astronomers finally rested in the belief that the new member of the solar system had been definitely chained down to its proper orbit, and that its place at any future time could be as certainly known as that of any of the veteran "seven wandering stars" of the ancients.

But this belief was not sustained by the future behavior of the undisciplined member. A gradually increasing gap between theory and observation became painfully evident till, in 1821, Bouvard undertook the revision of the planet's path. His investigations resulted in the perplexing discovery that while the earlier observations could be satisfied by a particular orbit, and the later ones also by another, no amount of mathematical ingenuity could bring these orbits into one and the same. Now, as celestial bodies do not change from one path to another without some external disturbing cause, the conclusion gradually forced itself into the minds of one astronomer after another that some important element of the problem had not been introduced, and that it would be extremely advantageous to have some reliable explanation of the vagaries of Uranus. The explanation could only be the existence of an undiscovered planet, exterior to Uranus, of such a mass, and at such a distance and direction, as, by its varying attraction, to effect the observed perturbations. Having given the mass and position of the disturbing body, it would have been a very simple problem, by the Newtonian law of gravitation, to calculate the effect of the disturbance. But the reverse problem, to calculate from the irregularities of the planet's motion, the circumstances of the attractive body, was involved in grave and peculiar difficulties. If the true orbit and the amount of excursion from it had been known, the case would have been simplified. But it must be remembered that the calculated orbit was based on measurements of the planet in its perturbed position, and therefore would not be the path resulting from the central attraction of the sun alone. The discrepancies resulted, therefore, partly from the continued disturbing effect of the unknown planet, and partly from the errors in the calculated elements, founded, as they were, on incorrect data. How much from each must be ascertained.

But however serious the task, the mathematics of the time, developed by the researches of La Place and his fellow countrymen, was equal to it. The data, in the hands of Adams and Leverrier, proved sufficient, and the tube of Dr. Galle's telescope, in Berlin, set according to instructions from Paris, pointed, with an error of less than one degree, in the direction of the planet Neptune.

This was in 1846. The observations on Neptune since that time have agreed quite closely with theory. But thirty-four years is but a small portion of the 165 necessary for a complete revolution, and hence the observations for so short a time, at the great distance of the planet, could not be expected to give the necessary data for a similar calculation of the position and orbit of an ultra-Neptunian member. They give no evidence of its existence, but they do not prove its absence. Some other method must, therefore, be found if we are to extend our knowledge of our system beyond the limits of the immense orbit of Neptune.

But if the unknown planet cannot produce the irregularity in Neptune necessary to prove its existence, it may have a stronger and more visible effect on those erratic members of our universe which serve as messengers from one system to another, and which only repeat their paths when constrained by a stronger influence. Prof. George Forbes, of Edinburgh, thinks that *comets* will furnish the data which the greater mass of the planets will not, for extending our acquaintance with our far-off brother orbs. His theory may be explained by the following considerations:

Suppose a comet to come in from exterior space in a parabolic orbit. The action of the sun alone might change this orbit, though still leaving it parabolic, and switch it off in a new direction, never to return. But if at the same time another body were to pass in front of the comet, and by its attractive force increase the comet's velocity in its path, the parabola would be converted into a hyperbola, and we must bid farewell to our heavenly visitant. If, on the other hand, the attractive body would pass behind the comet and diminish its velocity, the parabola would change into an ellipse, with the sun for the focus, and the position of the disturbing body for the aphelion. We would then expect to find a number of comets having their aphelion distances corresponding to the radius of each of the larger planets. Jupiter's distance from the sun is five astronomical units, and between four and six of these units are found the aphelion distances of eleven comets with elliptic orbits. These aphelia are scattered around the orbit, and would each represent the approximate position of Jupiter at the time the comet was there, if no other deflecting force had in the meantime acted on its path. Neptune's distance is thirty, and there are five comets whose aphelion distances are from thirty-two to thirty-five.

By tabulating the records of all comets having their aphelia outside of Neptune's orbit, Prof. Forbes found that two groups of six each had about 100 and 300 for their respective aphelion distances. This afforded evidence, upon which different astronomers will set more or less reliance, that at these distances from the sun, and near the plane of these aphelia, have revolved other planets, whose masses have had the effect to slow down the motion of vagrant comets, and introduce them to periodic movements around our center of attraction; and, moreover, that by considering

STATUE OF JOAN OF ARC, BY M. LEROUX, RECENTLY INAUGURATED AT COMPIEGNE, FRANCE.

the positions of these aphelia, and the time that the comets were last there, the time that the planets have been there would be known. In the case of the group at the distance 100, four of the aphelion positions are exactly in the plane of the same circle passing through the sun. It only remains, then, to find the circumstances of the revolution of a planet at this distance, which would bring it to or near these positions at the required times A planet of 100 earth's radii from the sun would have a period of about 1,000 years, and such a planet could be brought into the required positions in the course of two revolutions.

We will not go over the investigations by which Prof. Forbes shows that the probable plane of the planet's revolution is not necessarily in the plane of these aphelion positions, but that it might be in the ecliptic. In order to anticipate criticism as to the whole method, he took the group of Neptunian comets, and by a similar method computed the present longitude of their governing planet. He found that he could not bring these aphelia into a plane through the sun; hence, any hypothesis that required this had to be abandoned, but by the assumption that it was near the plane of the ecliptic he deduced the longitude of Neptune for 1880 at 45°. Its actual longitude is 48°. He says, in conclusion, "I think we may feel very confident that these planets do exist;" and this consideration is itself of great interest. The light of the sun must take fifteen hours to reach the nearest of these planets, and forty-five to reach the outer one; and α Centauri is only 750 times farther from the sun than the farthest planet, and 2,240 times farther than the other. Considering the probably enormous mass of the stars, it is nearly certain they must influence the motion of these two planets; and if we have the good fortune to observe either of them, a new field wherein to test the extent to which the law of gravitation holds good will be immediately opened to astronomers. Our ideas of time are in the same way extended when we think of these two planets revolving in periods, the one of 1,000 and the other 5,000 years; and when we consider that some of the comets introduced by the most distant planet were influenced by that planet tens of thousands of years ago.

In this connection we would call attention to the verification these planets afford of the prediction of Prof. Pliny Earle Chase, of Haverford College, Pennsylvania, as printed in the Proceedings of the Amer. Phil. Soc. for Feb. 7, 1873. He there gives the place of two ultra-Neptunian planets as 92·79 and 296·52 earth's radii, which agree near enough with Prof. Forbes' approximate positions of 100 and 300.

THE STATUE OF JOAN OF ARC.

THE City of Compiegne has celebrated the memory of the glorious peasant girl who, at the end of the war of one hundred years, revived the national feeling in France and drove the stranger, who had made himself almost absolute master of the country, from its domains. It is said that Joan believed her mission to be to crown the king, Charles VII., at Rheims. After the coronation, which took place on the 17th of July, 1429, she desired to return, but was detained.

After having lost all confidence in her she was defeated in Paris and fell back upon Compiegne, where she was besieged by the Burguignions. In a sortie she was made prisoner and delivered to the English, who put her to death in the most cruel manner, really a sad ending after such great triumphs. As statues to her memory had been erected in Domremy, Rouen, and Orleans, the city of Compiegne honored her memory likewise. The heroine is represented holding the standard of France in her left hand, and with the right hand she is giving directions to carry out an order. The head is raised, the hair flying, and she is armed with sword and cuirass, and is represented as marching to battle. The statue is the work of Mr. Leroux, was unveiled on the 18th of October, and is represented opposite.

THE UNHEALTHINESS OF PUBLIC INSTITUTIONS.*

IN a paper, read at the Sanitary Congress at Croydon last year, I drew attention to the sanitary defects which had been found to exist in some of the older public institutions in this country. Special reference was made to the Manchester Royal Infirmary, which had been reported by Mr. Netten Radcliffe, of the Local Government Board, to be unhealthy from cellar to garret. The defective health arrangements at the large lunatic asylums were referred to, and the condition of the County Asylum at Frome was selected as a typical example of the insanitary condition of the majority of such buildings. At neither Manchester nor Frome could reliable information as to the drainage arrangements of the buildings be obtained, and no proper plans could be found. It was further stated that investigation had brought to light the startling fact that not ten, and possibly not five, per cent. of all the hospitals throughout Great Britain and Ireland possess any reliable plan of their drainage arrangements. Even some of the most important hospitals in the kingdom had no such plans, and it would be easy to give instance after instance of the culpable ignorance which prevailed on this important subject. Remembering the foregoing facts, I asked what is the probable condition of the drains of all institutions built some fifty years ago?

Last year I specially referred to old institutions as opposed to recent buildings. By a sublime act of faith, I took it for granted that buildings erected within the last ten years would certainly not suffer either from insanitary construction or defective drainage. From the amount of attention which questions of hygiene have excited, and the numerous and competent authorities who have written and spoken on the subject in all its branches, it might at first sight have been taken for granted that architects of more or less eminence would have brought much intelligent study to the consideration of the right construction of drains and to that of sanitary arrangements generally. Unfortunately, experience proves the reverse to be the case, and, if anything, the newer the building the worse probably is its sanitary condition. Is it not time that the Royal Institute of British Architects took up this question of sanitary construction, and that its council should make regulations for the guidance, instruction, and training of the rising generation of architects? Such a course will ultimately guarantee the public against the defective, unhealthy, and discreditable condition of many public and private buildings which have been erected under the supervision and from the plans of some of the most eminent men in the profession. It is quite certain that the Royal Institute of British Architects must declare either that the profession repudiate all responsibility for insanitary defects in dwelling houses and large public institutions, because hygienic arrangements are no part of an architect's business, or they must promptly offer adequate guarantees to the public which will protect it from the disastrous results which now too frequently follow the occupation of a newly erected edifice. Suppose a wealthy client pays a large sum for the erection of a new house, which he has been assured by his architect is planned and arranged upon the most perfect system known to modern science. The professional adviser cannot expect that such a client, however much he may be reconciled to the anxieties and increasing expense of each addition to his family, will, without remonstrance, submit to an annual and increasing outlay for sanitary alterations and drainage improvements, rendered necessary by the carelessness or ignorance of the architect himself. It may be thought that new buildings are, as a rule, carefully erected, and that there is no justification for the foregoing remarks. Unfortunately for architect and client, such is not the case.

I hold myself responsible for the accuracy of the following descriptions of three new buildings, a hospital, a convalescent institution, and a lunatic asylum, all of which have been built, opened, and occupied within the last seven years. All names are purposely withheld.

The hospital had not been in occupation for more than eighteen months when the atmosphere of the building and the health of the inmates pointed to defective drainage and construction. An examination of all the drains, baths, and other conveniences proved the sanitary condition of the building to be most unsatisfactory. It soon became evident that very considerable alterations were needed to remedy the defects. This new hospital had, therefore, to be closed within three years of the date on which it was opened. A thorough investigation brought to light the following facts: The cisterns were placed so high that the pressure from the main was seldom or never sufficient to fill them. In consequence there was a gradual choking of the drains throughout the hospital, and an admission of sewer gas to all parts of the building. No manholes or means of inspection were provided, and the plans of the drains were found to be unreliable. With four exceptions, the drains were led outside the building, but the drains were very irregular. Thus, the level at the lower end of a drain was 1 in 60, higher up it was 1 in 24, and above this again 1 in 125. No wonder the drains were found to be choked. The pipes were also badly laid. In some places they were leaky, and very foul excrementitious matter was discovered in the soil near them. All pipes were pointed with clay, not embedded in cement, and few were water-tight. In fact, the defects were serious enough to guarantee the admission of sewer gas to all parts of the building. The hospital drains were in direct communication with the town sewer. The rain-water pipes opened directly into the drains; they were untrapped, and as they were only carried to a level with the upper part of the windows of the top wards, they conducted volumes of gas from the sewer to the wards. The soil pipes were all inside the building, and were trapped at the foot, and ventilated by smaller pipes carried up a certain height and then bent over. These traps were quite inaccessible, and the soil pipes were not properly ventilated, as they were only open at the top, so that no current of air could pass through them. As there was no inlet at the ground level, foul air was forced out through the lower closets into the hospital, whenever any considerable volume of water passed into the soil pipe from the upper floors. The slop sinks discharged into the soil pipes, and were practically untrapped, so that by their means sewer gas was led on to every ward in the hospital. There were other defects, and no one will be surprised that the sufferings of the surgical patients and the general unhealthiness soon compelled the committee to close the hospital.

The Convalescent Institution stands in its own grounds of eight acres. It is beautifully situated. It has extensive gardens and every convenience, not to say luxury, that modern taste could suggest. The cost of the site, buildings, etc., was upwards of £50,000; there is accommodation for some two hundred patients, and it has been occupied for less than five years. Within a year of its being opened there was a sharp outbreak of erysipelas among the patients, and the institution was closed and fumigated. It was noticed at the time that all the conveniences opened into the building, directly opposite the wards, and a suspicion of defective drainage arose, but was not credited, owing to the fact that the building had been occupied for barely one year. A few months ago the unhealthiness of the institution was so marked that the committee gave instructions for a complete examination of the drainage system. No plan of the drainage could be found, but one was ultimately furnished by the architect, which proved to be incorrect in many particulars. All drain pipes, etc., were found to be in and beneath the building. The baths, lavatories, and sinks opened directly into the sewer, and many were untrapped. In that portion of the building allotted to the officers, owing to an ingenious arrangement of the lavatories and the pipes connected with them, sewer gas was admitted at both ends of each floor. The ventilation of the drains and sewers was so defective that during certain winds the sewer gas was driven through and into the building by means of the ventilators. Some of the drains were laid up hill, all were pointed with clay, and not embedded in cement, all leaked, and the main sewer, as it passed from the building, was laid at irregular levels, and in more than one place, owing to imperfect workmanship and improperly-made ground, the pipes of which it was composed were not in contact with one another. The main sewer had to be entirely relaid. All the drains were taken up, and with the soil pipes were placed outside the building. It is not to be wondered at, in the face of the foregoing facts, that, instead of being a convalescent institution, these defects of construction compelled the convalescents to return, not to their own homes, but to the hospitals from which they came; while the majority of the resident staff were placed on the sick list. Yet the architect had in this case unlimited funds at his disposal, and the fullest liberty to do all that he thought necessary or desirable.

The County Lunatic Asylum has been opened for the reception of patients for five years. Built regardless of expense, it was supposed to contain all the most recent improvements in lunatic hospital construction. Almost from the date of its occupation it has been the scene of outbreaks of dysentery and erysipelas. During the first eight months of 1879 cases of these diseases were of constant occurrence on both sides of the asylum. There were twelve fresh cases of dysentery and four of erysipelas every month. Suspicion having fallen on the state of the drains, ultimately a competent engineer was appointed to examine them. Numerous faulty points in the system were detected, and their rectification has been followed by the disappearance of dysentery and erysipelas from the establishment.

I have here given positive proof, from the experience of the past twelve months alone, that the architects who have been intrusted with the erection of these large public buildings devoted to medical purposes, have shown an ignorance, or, if you prefer it, a total disregard, of sanitary laws and requirements. I refrain from comment, but I appeal to the Royal Institute of British Architects to apply a remedy which will prevent like abuses for the future. If they fail to do this, then let them boldly hand over all matters affecting drainage and sanitary construction to the engineer. By this means they can readily avoid a heavy responsibility, and save their profession from much discredit.

It behooves the public to take the question up from a different point of view entirely. Private houses and public institutions are not free, as they ought to be free, from preventable impurities, and they are too often highly dangerous abodes for any one who has a tendency to zymotic disease. No permanent prevention is likely to be secured without a thorough, an independent, and a periodical inspection of all the structural and drainage arrangements of these buildings. A central office for the safe custody and registration of the drainage and other plans of all public buildings, hospitals, and private houses, is a much-needed reform. Competent inspectors and a central repository might be secured for a reasonable outlay, which would be over and over again repaid to those who were sensible enough to avail themselves of its facilities. At the present time no one seems to think of drainage arrangements. Nearly every one is contented with a taking exterior. Yet the magnificent elevation of the block of new buildings known as the new Foreign Office did not protect its inmates from the inconvenience attending the presence of several inches of liquid sewage, which was found in the basement of the Home Office within a few weeks of its occupation. Could the Congress better employ its time than in appointing an influential deputation to the Local Government Board, who would strongly recommend the adoption of the necessary remedies for the removal of the evils brought out by the facts detailed in the paper?

* A paper, by H. C. Burdett, read at the Sanitary Congress, Exeter, Eng., Sept., 1880.

CLOTHING IN ITS RELATION TO HEALTH.

THE ideas and scientific views of Prof. Dr. Gustave Jaeger, of Stuttgart, regarding the properties of animal wool, gain more and more in popularity with German scientists, and in one of the latest numbers of the *Homœopatische Monatsblatter* (Homeopathic Monthly), which appears in Stuttgart, Dr. E. Schlegel, a well-known physician of Tübingen, has published an essay, in which he speaks of Professor Jaeger's theories as follows:

Among the discoveries that have been made during the last few years in medical science, some facts brought to light by Dr. Gustave Jaeger regarding the amount of water contained in the human body may prove to be of the utmost importance. In his paper concerning "The resistibility of the human body against epidemic diseases and the power of constitution,"* Professor Jaeger has proved that the specific gravity of several individuals is very different, and that the state of the health of those individuals is closely connected with their specific gravity. The greater the weight of the human body in comparison to the space which it occupies, *i, e.*, the greater its specific gravity, the more it is able to resist epidemic diseases. Persons of a low specific gravity are taken ill from very insignificant causes, such as a cold, and are very susceptible to contagious diseases. Such persons have usually a certain fullness of body, and are even corpulent, but just that which gives them a great size is useless ballast, namely, fat and water. These substances endow the heaviest bodies with a comparatively low specific gravity, giving at the same time to the constitution little power of resistance.

Very different is the case with bodies of high specific gravity. Here neither fat nor water is superabundant, the flesh feels solid, and the bodily constitution possesses a high power of resistance. Professor Jaeger has investigated these differences of constitutional resistibility by comparing the specific gravity of a number of persons with their state of health. An accumulation of water in the tissues of the body he calls "Hydrostasis chronica," an expression which, as the whole discovery itself, reminds us of the teachings of the homeopathist Von Grauvogel respecting hydrogenoid constitutions, while the theory that a chronic accumulation of water in the body is the cause of many sicknesses is in perfect accord with the "Sykosis" described by Hahnemann, and afterward by Wolf.

The investigations and measurements of Jaeger are of an entirely new date, and we would not mention them here had not this discovery proved to be of the highest value for hygiene, and had not the conclusions of Professor Jaeger already been corroborated in a most remarkable manner.

If it is true, namely, that the specific gravity of the body is the measure of its resistibility of disease, and if it is also true that few bodies have this resistibility, because of an overabundance of fat and water, then the question arises, Have we any means of counterbalancing this superabundance and therewith heightening the specific gravity? The homeopathists know a number of remedies for so-called hydrogenoid constitution, the most important of which is "Thuja." These remedies have to be chosen according to the individual constitution, and have proved to be of more or less benefit, sometimes even effecting a perfect cure. Allopathists use also several medicaments which are useful in cases of "Sykosis," but none of these remedies are entirely satisfactory.

Professor Jaeger has now, by his careful investigation, discovered a simple and natural expedient for preventing the accumulation of fat and water in the system, which is suitable alike for rich and poor. It consists in adopting a new sort of clothing, we might call it a normal clothing.

The Professor has tested the value of his discovery upon his own person and members of his family, and so has the writer of these lines, who, after having the honor of making the acquaintance of Professor Jaeger in 1879, adopted, at his suggestion, the normal clothing, and recommended it to some thirty or forty persons since. The experiments made by wearing the clothing in the heat of summer and the cold of winter has proved highly satisfactory.

The normal clothing has two essential properties:

1. It consists exclusively of wool, avoiding all materials woven from plant fiber (cotton and linen).

2. It makes a strong point of keeping warm the middle line of the front of the body.

The principal peculiarity of Professor Jaeger's clothing is the exclusive use of sheep's wool, even avoiding pocket and other linings of cotton.

To every thoughtful person it will be a source of satisfaction to know that Professor Jaeger has chosen for the warming of the body only those means which nature has given

* "Sencheneschutz und Constitutionskraft."

for the same purpose to those mammals which are the most nearly related to man. The fittest and the most suitable always predominates in nature, and if, in this case, we inquire why hair and wool clothing are the best protection against cold, the answer will be found in the physical properties of these matters. A cover of wool is far more porous than that of plant fiber. The latter, if exposed to moisture, becomes thoroughly soaked with the liquid and sticks to the body, so that no air remains between, and only one smooth evaporating surface is formed, whereas a hair or wool cover being never entirely soaked does not cling closely to the body, but forms a surface which is broken by air bubbles, permitting a great quantity of moisture to pierce to the outside, where it can evaporate. Moisture from the outside is prevented from piercing through the cover to the body on account of the layer of air between the cover and the body, which offers a kind of resistance.

These properties of hair and wool clothing are very important, for the skin of each animal is a source of evaporation, and continually renders moisture to the air.

That difference which exists between plant fiber and wool in regard to the conductibility of heat, renders the superiority of wool clothing in regard to health still more evident. Wool is a bad conductor of heat, therefore wool clothing conserves the heat produced by the body, while cotton, and still more linen, permits this heat to quickly escape and eradiate. This fact accounts for the cool, chilly feeling produced in putting on linen clothing, while in putting on woolen no loss of heat is felt.

The conservation of the heat of body produced by woolen clothing has the consequence that the skin remains in a blood-rich state, and may perspire more freely than when exposed to a quick refrigeration by cotton or linen clothing.

To these important properties of wool, which are sufficient proof of its suitability for clothing, a new one has been added by Professor Jaeger's latest investigations, which we will only mention briefly, as an explicit description would occupy too much space.

Jaeger has proved that in our organism there are certain gaseous volatile substances, called by him "Duftstoffe" (odorous substances), which play a very important part, as yet undivined. He endeavors to show that the actions of our mind are mediated by these substances, and that they are continually rendered free in the acts of breathing and perspiring. He discerns two different groups of odorous substances—"Lust and Unlust Stoffe" (substances of pleasure and disliking). The first ones are exhaled during a joyful and agreeable state of mind, and produce this state of mind if inhaled. Just the reverse is true of the second ones. Whoever will take the pains can discover for himself that the evaporation differs according to the condition of the mind as well as the condition of the body. During joy and happiness the odor of perspiration is not disagreeable, while during anguish and great nervous excitement it is offensive. The substances of disliking have, therefore, a bad odor. In an atmosphere of these substances the vitality is lowered and disadvantageously influenced. This accounts for the fact that in a state of anguish and fear the body is more susceptible to contagious diseases. The inhaling of the "substances of pleasure" heighten the vital actions and improve the resistibility of the body against sickness. Jaeger has now discovered that "sheep's wool" attracts the "substances of pleasure" [this property must not be confused with the great capacity of wool for absorbing odors in general], while clothing made of plant fiber favors the accumulation of the offensive "substances of dislike," with all their evil consequences.

Even with healthy persons, cotton and linen clothing, after long wearing, takes a distinctively repulsive odor, while woolen clothing, even in summer, when evaporation is strong, takes only the sour smell of perspiration, and never accumulates other offensive smells. This seemingly unimportant fact, the mention of which may be ridiculed by many, is, nevertheless, of the greatest value to medical science, and has proved of the highest importance for the "resistibility of the human body against contagious diseases."

Thus far Dr. E. Schlegel. The full responsibility of this report of the hypothesis of odorous substances we have to leave to the editor of the "Homeopathic Monthly," in Stuttgart, and its learned contributor, but we believe that the facts are very interesting and of great value, as they are based upon exact scientific investigation. Especially deserve to be mentioned the several thousand experiments regarding odorous substances which have been made with the "chronoscope," an instrument by which the celerity of nervous conduction is recorded.

PROF. JAEGER'S NEURAL ANALYSIS.

PROF. JAEGER'S theory of "Lust and Unlust Stoffe" is mentioned in an article entitled "Clothing in its Relation to Health," which we publish in this number of our SUPPLEMENT."

This new theory, if true, has too great a value to be ignored.

Prof. Jaeger sent to the *Ausland*, at the request of its editor, the graphic illustrations of his experiments with the chronoscope. These illustrations are reproduced in Figs. A, B, C, I., II., III., IV., and the following is a translation of the explanation given by the author himself in regard to his so-called "Neural Analysis":

"My discovery relates chiefly, to use the language of physiology, to the *Gemeingefühl* (collective feeling—emotions), which, by physiologists, is distinctly separated from the *perception of the senses;* the latter is connected with the *idea*, and follows the law of isolated conduction (the philological difference of *soul* and *mind* corresponds exactly to this physiological difference). The essential peculiarity of the "Gemeingefühl," *i. e.*, emotions, is that the accompanying functional changes are not limited only to a few anatomical parts of the body, but concern all parts of it (muscles, nerves, glands, etc.). *Emotion is a change of the condition of the whole body.* Therefrom follows that not only the sensory nerves partake of a change, but also the muscular nerves (and the muscle itself). That which is changed is the nervous excitability, and that which produces the changes is soluble substances, which enter into the liquids of the body, and among which the volatile ones (Duftstoffe—odorous substances) have the greatest effect. The changes of excitability are indicated by the motoric nerves as a quantitative change of the conductibility of these nerves for perceptions. By this we are enabled to illustrate graphically the peculiarity of emotions: by a double method, using a *voluntary movement*, we measure, by means of the chronoscope, the time which passes until an optical or acoustical signal is answered by a pressure of the finger (this time is called by astronomers the "personal equation"). I have used this method in my "Neural Analysis," as indicated in the illustrations; using an *involuntary* movement, viz., the movement of the heart. Although I have not yet employed this latter method, I may, nevertheless, say with certainty, just as each "Duftstoffe" (odorous substances), when entering the liquids of the body, produces a specific fluctuation of the personal equation, so it will also produce a change of the rhythm of the heart and the pulse, which may be measured by the *sphygmograph*, and will also be of value for the "Neural Analysis." I would like to ask those of my colleagues who possess a sphygmograph to investigate whether each inhalation of a certain odorous substance does not produce a specific curve of the pulse movement, and whether the characteristic changes of the pulse movement during sickness are not simply the effect of the odors of disease appreciable to the smell.

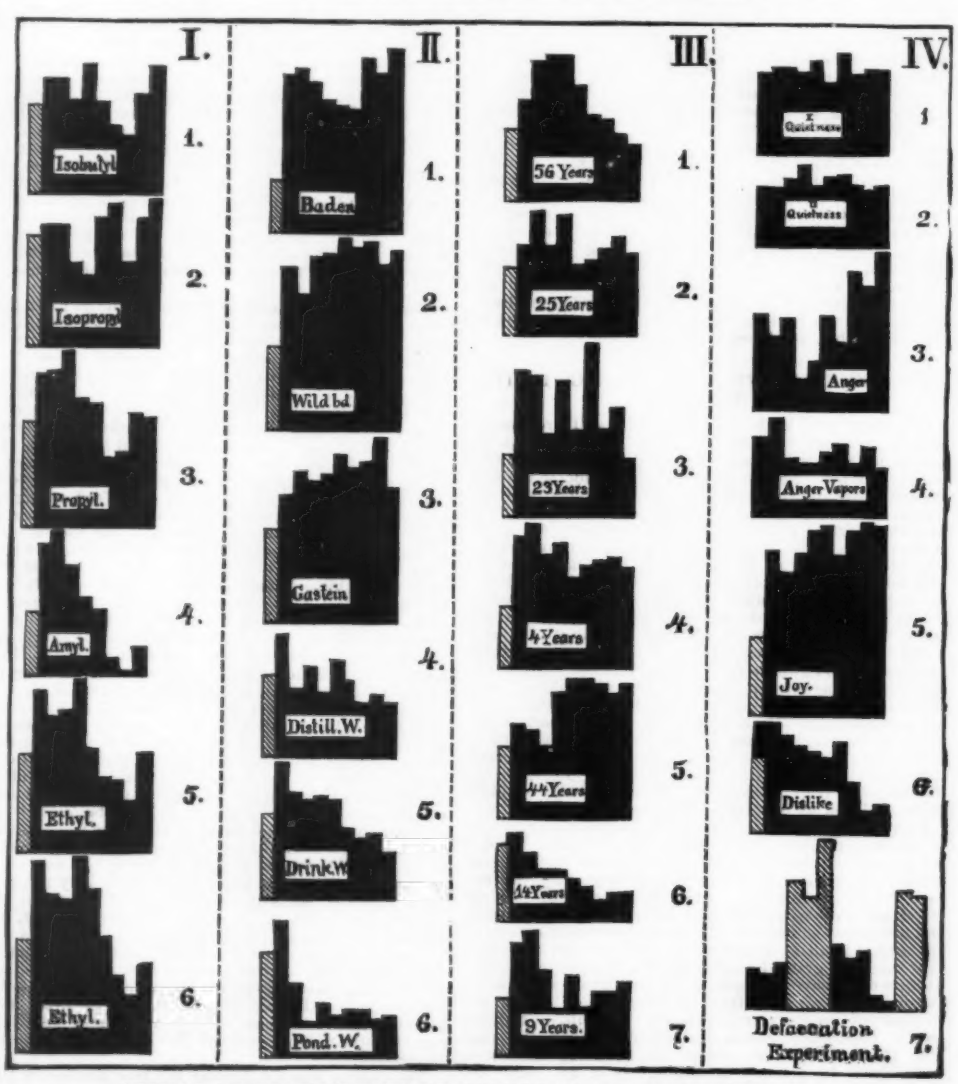
To be short, Neural Analysis is an operation by which the muscle nerve indicates what the nerve of smell smells, and what the nerve of taste tastes, these nerves being influenced in the same manner by matter which is appreciable to taste and smell, as the chemical sensory nerves are. The curves illustrated in our figures will be explained by the following: A, B, C, give three detailed curves for the most important states of consciousness, and these curves are produced by the inhalation of the smells of different objects. The hatched part of the curve was found by ten measurements before the beginning of the inhalation, while the rest represents the result of the measurements of the personal equation made during the inhalation every twenty seconds.

Fig. A is the *curve of joy*, produced by the inhalation of the odor of that kind of pears of which I am most fond. The characteristic property of the joy curve is, *a*, a high

CURVE OF JOY PRODUCED BY THE ODOR OF PEARS.

CURVE OF ANGER PRODUCED BY THE ODOR OF RANCID BUTTER.

CURVE OF NAUSEA PRODUCED BY THE ODOR OF BAD DRINKING WATER.



NEURAL CURVES PRODUCED BY SMELLING DIFFERENT SUBSTANCES.

NEURAL ANALYSIS.

horizon of it; *b*, great amplitudes, *i. e.*, very different lengths of the co-ordinates, therefore great oscillations of excitability; *c*, regular rhythm of these oscillations.

Fig. B is the *curve of anger*, produced by the inhalation of butyric acid. It is well known that many persons become very irritable on eating rancid butter, or even on eating fresh butter, which produces a fermentation of butyric acid in the stomach. It is characterized by, *a*, a horizon of me-

dium height; *b*, great amplitudes; *c*, very great irregularity of the rhythm, as the horizontal series of numbers indicates.

Fig. C is the *curve of nausea*, obtained by inhaling the smell of the city water of Stuttgart, which consists of pond water filtered. The characteristic peculiarity which it has is, *a*, low horizon; *b*, great amplitudes; *c*, great irregularity of the rhythm.

The other figures represent *average curves*, obtained by the reduction of one hundred measurements to ten average values. These curves, therefore, only indicate the horizon of the single curves, not giving the rhythm and the amplitudes. The hatched co-ordinate shows the personal equation before the inhalation, and, therefore, is a measure of the physical predisposition.

Fig. I. gives the *curves* of the *different alcohols;* the great difference between the iso-alcohols and the normal alcohols is striking, and is also the similarity which the representatives of each of these two classes bear to each other. The fifth and sixth curves represent how high a degree of similarity exists in curves produced by the same object, even when the measurement is made with persons of different disposition (the intervals were 5·87 mill seconds to 6.80 mill seconds). Finally, it may be remarked that a curve of amyl-alcohol corresponds to the nausea curve, which indicates perfectly the influence of bad liquor.

Fig. II. shows how erroneously the springs of Baden, Wildbad, and Gastein, are called indifferent thermal waters. These wells contain a nervine of great effect, which has been hitherto unknown to our chemists, and give also a proof of the analytical accuracy of the *Neural Analysis*, which alone was able to detect the difference in waters of a character otherwise so similar. The comparison of these curves with curve 4 shows how great was the mistake in classifying the so-called "indifferent" thermal waters along with distilled water. Fig. 4 shows the curve of the smell of distilled water (but perhaps this water was corrupted by the smell of fungi); 5 and 6 are again a new proof of the diagnostic delicacy of the "Neural Analysis." If the smell of one-eighth liter of water (about one-fourth of a pint) produces such a depression of nerves, then it is a crime to lead such water into cities. (The water was taken from the pipes of the city water works of Stuttgart.)

Fig. III. gives the curves of the smell of the hair of different persons. It shows, *a*, that these smells have the same physiological importance as the smell of other natural objects as regards the producing of consciousness; *b*, that by means of "Neural Analysis," not only the age and sex of different persons, but that also persons of the same sex and age, can be easily recognized; *c*, that here also the contrast between sympathy and antipathy is very distinct, 5 being a fine curve of joy, while 6, representing the smell of an immature girl, is a plain nausea curve.

Fig. IV. shows firstly in Nos. 1 and 2 that the condition of mental quietness is indicated by a very even curve, but even here the difference of physical dispositions may be recognized by the horizontal oscillations. Neural Analysis offers, therefore, the means for the qualitative investigation of physical disposition; No. 3 shows the extreme oscillations of nervous excitability after an outburst of anger produced by endogenous influence; and No. 4 shows that by inhalation of an odor-destroying essence (ozogene) this physical alteration can be at once removed, because five minutes after the curve of anger had been ascertained, this curve was produced by the influence of an inhalation of ozogene. Nos. 5 and 6 illustrate the conditions of pleasure and dislike which are produced by the perspiration of the human body *if the odor is inhaled;* they are, therefore, plain proofs that endogenous joy and dislike are produced by the odorous substances. Besides, they prove that the body secretes two kinds of odorous substances (Lust and Unlust stoffe), "substances of pleasure and of dislike," and it also demonstrates the fact that woolen clothing collects the substances of pleasure—curve 5 is produced by the inhalation of the smell of a woolen shirt—while ligneous fiber retains the substances of dislike. Curve 6 was obtained by the inhalation of the odor which was produced by a linen collar worn for the same length of time as the shirt. By these results the practical value of my theory, as to a reform of clothing, is made manifest.

Finally, the 7th curve of Fig. IV. illustrates the experiment of "defæcation," at the mentioning of which my lecture in Baden was interrupted. Of all my experiments, this is the most important and the most conclusive for the theory of affections. The first three average values, which indicate the condition of disliking and nausea, were obtained immediately before the act of defæcation, while the three following values, which represent the condition of pleasure, were obtained after this act. When I then again inhaled the smell of the fæces the nervous excitability was lowered to the same degree, and even more than before, as the next five co-ordinates show, and this is a proof that only the odor is the agent that influences the nervous excitability and determines the emotions. Indirectly, this was proved also by the next experiment. After an exhalation of the fæcal odor in fresh air, which lasted for five minutes, I received last two co ordinates of the curve, which indicate nearly the same height of the feeling of pleasure as those co-ordinates of the curve which were obtained right after the act of defæcation. To each half-ways expert reader, it will be plain that this experiment is absolutely conclusive for my theory of affections. With it it is *undeniably* removed from the field of hypothesis into that of exact truth.

[THE MEDICAL RECORD]

INDUCED HYSTERICAL SOMNAMBULISM AND CATALEPSY.

ABOUT the court-yards and the wards of Salpêtrière, pursuing various occupations, such as reading, sewing, and assisting here and there, one may see any day a goodly number of patients, whose appearance is far from suggesting that they are the subjects of the violent convulsive attacks incident to hystero-epilepsy. Unlike the epileptics—the class that would most nearly correspond in respect to this apparently normal interval—these patients present no sign of intellectual dullness. The hystero-epileptic is bright-witted and vivacious; the epileptic, dull-witted and listless. But a day later we may see any one of these intelligent and seemingly healthy young women launched into a long series of violent crises, such as described in my last letter. Having then fully considered the "attack," we may now at leisure give our attention to the behavior of these same patients at other times.

In the first place, their condition in the intervals between the attacks is by no means as normal as it appears. To say nothing of that emotional instability (disposition to laugh and cry, etc.) so characteristic of the hysterical, there will be found, on examination, certain tolerably permanent physical changes relating to the general sensibility, the special senses, and the muscular sense and force; indeed, it would be safe to say changes relating to the whole innervation of given districts—in most instances an entire lateral half of the body. For instance, all of these patients will be found to be hemianæsthetic, generally on the left side; pinching, cutting, or burning produces no sensation of pain, nor do tests of temperature, position, etc., provoke their normal responses; in short, the cutaneous anæsthesia is absolute; they are equally hemiparetic, or, to use a milder term, perhaps, hemiamyosthenic; tested by the dynamometer their muscular power is found to be weakened on one side or the other. If the examination is pushed farther, the hemianæsthesia will be found also to involve the mucous membrane and the special senses—all this on the same side of the body. The hearing is dull; the eye is amblyopic, and fails to distinguish, perhaps, any color whatever, or, if the entire field of vision is not achromatopsic, distinguishes the red or the yellow; and the sense of smell and of taste are also abolished.

The only exception to this almost absolute obnubilation of nerve-function upon one side is the existence of a certain number of hyperæsthetic and at the same time hysterogenetic points or regions. At these points the cutaneous anæsthesia is as complete as elsewhere, thus presenting a ready means of diagnosis from dermalgia, in which the cutaneous sensibility is exaggerated to such a degree that a slight touch even may produce intense pain. The hysterogenetic regions, on the contrary, are more deeply situated, and are characterized by the peculiarity that slight pressure upon them, or other form of light irritation, will produce the complete hystero-epileptic seizure, or at least certain auræ, while strong and continuous pressure will produce an arrest of the seizure, however originating. This, contradictory as it seems, has been demonstrated again and again, until, by mere force of repetition, it has become an acknowledged law. Chief among the hysterogenetic zones is the ovary.

But all the symptoms just alluded to may be taken up more suitably in connection with the effects produced by magnets, metals, and static electricity. They have been mentioned here only, since they take a natural precedence of the more novel symptoms whose description follows, viz., induced hysterical somnambulism and catalepsy.

One morning Prof. Charcot very kindly had a number of these hystero-epileptic young women summoned, and demonstrated, as he has already done hundreds of times on numbers of different patients, certain phenomena, which I will attempt to describe as they occurred, always asking my readers to remember that I have no other office, for the present at least, than that of a simple mirror, which reflects to their eyes the morning clinic at Salpêtrière.

In approaching the subjects of induced hysterical somnambulism and catalepsy from a scientifically medical point of view, I cannot forbear quoting some very pertinent words of Doctor Paul Richer, formerly interne at Saltpêtrière, in regard to the spirit in which the work has been prosecuted. "Despite the difficulties of all sorts," writes Dr. Richer, "which such a subject must, in the nature of things, present, M. Charcot has not hesitated to begin this study; for he thinks that all natural phenomena, whatever may be their appearance of complication or of mystery, are none the less susceptible of methodical examination, and that it is the part of a true observer to guard himself, as well from denials easy to make from the standpoint of having prejudged a case, as from the danger of giving too free rein to the imagination. It is no more allowable to deny facts rigorously observed than it is to rest upon a single incomplete observation theories which, at the least, are premature."

I.—SOMNAMBULISM AND INDUCED DELUSIONS.

The first patient brougnt into the clinic was Witt——, a young woman of about twenty years of age, large, finely formed and muscular, and suggesting in personal appearance no idea that she differed from healthy people. Her hereditary antecedents, however, from a neuropathic point of view, were bad; her father had been insane and her mother "nervous." Hystero-epileptic attacks began at the age of fifteen, but were not very frequent. At eighteen they became frequent, and the *series* longer, and she was admitted to Salpêtrière. Her case is a perfectly typical one. All the familiar symptoms may be studied in it: hemianæsthesia, hemiparesis, ovarian hyperæsthesia, hysterogenetic zones, achromatopsia, etc. She had been summoned, on this occasion, for the examination of two additional symptoms—somnambulism and catalepsy.

Having first established the fact, by indiscriminately thrusting large needles through her skin, that a complete hemianæsthesia existed on the left side, Prof. Charcot asked her to be seated, and to look at his finger, held a few inches above and in front of her eyes. Her look remained fixed upon the finger for perhaps ten seconds, and then all at once her head fell heavily to one side, her eyes closed, there was a slight sound and movement of deglutition, and the patient slept. Her body was in a state of complete resolution; if an arm was raised by the observer, it fell again heavily.

The process just witnessed is most commonly known as hypnotism, the state as that of somniation, somnambulism, or, as proposed by Prof. Charcot, since it involves no theory, lethargy. The patient will remain in this condition of somnambulism (retaining for the present the more familiar term) for many hours, but may be aroused from it at any moment by blowing quickly in the face, when, upon awakening, she will be found to retain no recollection of anything which has occurred during her sleep. We may now note a most interesting phenomenon characteristic of this state; this, discovered by Prof. Charcot, has been named by him muscular hyperexcitability.

If, for example, we press lightly upon any muscle we choose to select, or, better still, rub it with moderate force, we shall at once produce in it a persistent contracture, and that to an extent of rigidity depending upon the degree to which we have excited it. Light pressure or rubbing produces slight contracture, strong pressure produces extreme contracture, and, as indicated by the word contracture, the muscular contraction produced is persistent. In order to undo or resolve this contracture it is necessary to rub, and thus excite, the antagonistic muscle until the member or trunk has resumed its natural position. The method of producing this contracture most nearly recalls that pursued in electrization at the usual electromotor points. But it does not appear that one need confine himself to these points.

Let us see how what we have just described applies to our patient, now asleep with head drooped, and reclining in the chair before us, a helpless subject for experimentation. The left sterno-cleido mastoid is rubbed several times with the point of the finger, and straightway this muscle stands out like a rigid column in the neck, producing at the same moment its usual action of turning the face around to the right; we have a perfect torticollis which, left to itself, would persist at least for a number of days. But the opposite sterno-cleido mastoid is now rubbed and contracts until the face looks directly forward, and the torticollis is resolved. The flexors of the forearm are pressed upon and rubbed, and they at once become rigid, flexing of course at the same time the hand upon the arm. If the irritation be continued the muscles become extremely hard, and the bystander, by any force which he can reasonably exert, cannot overcome this flexion. But it may be at any moment resolved by rubbing the corresponding extensors. Or a number of muscles may be contracted at once—the flexors of the forearm, and we have flexion at the wrist—the biceps, and the forearm flexes in the upper arm—the pectorales, and arm and shoulder draw inward and forward, recalling in features the contracture seen in hemiplegia. But all this may be resolved at once, if the bystander or operator chooses, by simply exciting in turn the natural antagonistic muscles.

In short, it was perfectly evident that each muscle in the body could be made to exert and maintain its normal action. This was the more patent when demonstrated upon small and isolated muscles. Taking for convenience a penholder, its blunt end was pressed upon the attollens auriculæ, at once the ear was elevated; or upon the retrahens, and the ear moved correspondingly. I satisfied myself of this again and again, not only in the case of Witt——, but in that of several others, by selecting isolated muscles with special actions, generally taking the familiar electro-motor points for the experiment. Pressure upon the pronator longus, and pronation alone ensued—upon the supinator, and supination resulted; or, for variety, upon the two extensors of the thumb, and each acted upon its proper phalanx.

A most interesting demonstration was to select in turn, using the end of the penholder, the group of muscles about the thumb—nothing could be more exact than the results elicited—an opponens, an abductor, an adductor, a flexor; each in turn responding by throwing the thumb into corresponding positions, each of which positions persisted as a contracture until resolved by exciting an antagonistic muscle. In the same manner any single muscle of the face was made to contract. The experiment, of course, was susceptible of an endless variety of combinations. The very natural suggestion arises, may not the future anatomist, who writes upon the action of muscles, contribute much to scientific accuracy by studying from such a subject as Witt——?

But the same kind of contractions may also be brought about by exciting by pressure the trunks of nerves. Pressure upon the ulnar at the elbow produces a fixed state of contraction in all the muscles innervated by this nerve. If the facial nerve at its exit in front of the ear is pressed upon, the mouth and side of the face is drawn strongly to the corresponding side, though owing to some as yet unknown law of exception the contraction of the facial muscles remits as soon as the irritation is removed.

Up to this point it has been possible not only to produce a contracture, but to resolve it at will—the patient, it must be recollected, being all this time in a state of somnambulism. But we may create a contracture which cannot be thus removed. We will suppose that, having produced a strong contracture of flexion at the wrist and at the elbow, one blows quickly in the face of the subject and wakes her up. She blinks her eyes, stares about her a few seconds to get her bearings, and then suddenly discovers that her arm is rigid; she tries in vain to move it; it seems as firm as metal, and thus it will remain for several days if left to itself. The physician cannot now, as previously, resolve this contracture by rubbing the antagonistic extensors.

True, a very strong faradic current applied to the extensors will overcome the contracture, but the moment the current is remitted the arm flies back to its contractured state almost as if it were a steel spring put on the stretch and suddenly let loose. There is but one means of resolving this state of affairs, and that is to again put the patient to sleep; the contracture may then be made to yield on the instant to the usual process of exciting antagonistic muscles. The patient, for example, may be waked from her somnambulic sleep with an artificially produced torticollis. One may imagine how very puzzling this would be to a physician not knowing the history of the case. If we recall in this connection the fact that exactly these same contractures may occur spontaneously in the hysterical, we see at once the important bearings of these cases of artificially produced contracture.

I recall, for instance, in the case of an hysterical girl, a torticollis which was operated upon by tenotomy again and again by a distinguished surgeon, and treated by apparatus for months—all without the slightest curative effect. In another instance the tendo Achillis was cut more than once in the same kind of a patient, equally with no result. Such cases at least are suggestive.

The experiment of waking the patient with a contracture which neither she herself nor any one else can relieve (without again hypnotizing her), is, of course, like the first series of experiments described, subject to many combinations. Some of the contractures thus produced and left to the patient may be ludicrous, and some more or less distressing and dangerous. Often the tongue is contractured by pressing the finger upon its base and thus rendered immovable; the patient is waked and finds herself speechless. Or again, in too much manipulation about the neck, muscles of the larynx become contractured, and a distressing and persisting laryngismus stridulus is produced.

Our patient, Witt——, has thus far been in the first stage only of the induced sleep—a stage most familiarly known as that in which the patient may wander about (whence the term somnambulism), answer questions, obey commands, etc. Up to this point we have examined only a single characteristic of this stage, viz., the muscular hyper-excitability, since this one point is not only a newly discovered one, but has also an extreme practical interest in its relations to every-day practice. We will pause for but a word in regard to induced hallucinations, another characteristic of this stage, and then pass on to the second, or cataleptic stage, where we may also pause by the way to observe induced aphasia.

Two simple experiments performed on another occasion with Witt—— illustrate the method of producing hallucinations. Witt—— is hypnotized; her eyes are opened by the operator, and she is told to look carefully at the bystander—that be is Ernestine, a young woman friend of hers present. Her eyes are then closed. Ernestine is now led up, Witt——'s eyes opened, and she is told several times that Ernestine is the bystander, and her eyes again closed. The operator now blows quickly upon Witt——'s face. She wakes, and at once addresses and treats the bystander as

Ernestine, and Ernestine as the bystander. This delusion persists a long time unless Witt—— is again put to sleep and the hallucination removed by reversing the process of its creation.

Or again, Witt—— is hypnotized, her eyelids held open, and the operator directs her attention to a spectator upon whom he is pretending to greatly elongate the moustache, pull up the collar to a ridiculous height, form colored rings around the eyes, and otherwise figuratively represent him as ludicrous. These pantomimic motions ended, Witt——'s eyes are closed, and she is awakened. She takes a second or two to recover her wits, and then looks up. She catches sight of the spectator thus transformed to her eyes, breaks into laughter, and runs away, saying, "Oh! what a droll man," "Who is he?" etc. This impression will, as in all of these instances of provoked or induced hallucination and delusion, remain for all day, or perhaps several days, unless dissipated, as already described.

There is, of course, infinite variety to this experience. We have only to delineate to the eyes of the patient the crucifixion or the image of the Virgin Mary, and we shall at once have all the attitudes and expressions of veneration, love, worship, and beatitude, just as recounted in multitudes of histories where undoubtedly these hallucinations have occured spontaneously, as they often do in this numerous class of excitable women.

II.—CATALEPSY AND INDUCED APHASIA.

Witt—— thus far then, as we have just said, has been in the first stage of the induced sleep, that of somnambulism. We recall that the trunk and members were in a state of resolution, and the eyes closed. She may now, in the simplest manner imaginable, be made a cataleptic, and thus enter a second stage, accompanied with new phenomena. The upper eyelids are raised by the operator, and it is done. A slight sound and movement of deglutition announces the transition, and perhaps a little foam in the corner of the mouth. There is now no isolated "muscular hyperexcitability." We press and rub the muscles in vain; there is no contraction or contracture. On the contrary, an altogether different condition exists; body and limbs now maintain any position in which they are placed; in short, we have the condition familiarly known as catalepsy. If the arm is raised to a right angle with the body, it remains so; if the leg is placed in a similar position, it does not fall. The patient may be moulded at will, like a waxen figure, into any pose one pleases, and the position will be retained. The patient is totally anæsthetic, whether so previously or not. She makes no response to questions, nor in any way gives any sign of being in communication with the external world; the eyes are wide open. There exists but one method of producing in her any external evidence of intellection. This constitutes the curious phenomenon called "suggestion." If, for instance, the now waxen limbs are placed in a pose which indicates aversion, *i. e.*, with the arms fully extended in front and the palms of the hands turned outward, the muscles of the face at once contract, and its whole expression is that of aversion. If, again, her hand is placed at the lips, as in the act of throwing a kiss, the face at once breaks into a smile.

The catalepsy may be equally simply resolved by closing the eyes. The arms, for instance, a second before raised and fixed like those of a statue in a given attitude, fall, at first slowly, then more quickly and heavily, downward. The whole body is now again in a state of resolution. We have returned from the stage of catalepsy to the first stage, that of somnambulism. Or, the experiment of transition may be varied in an interesting manner. The patient, we will say, is in the first stage, that of somnambulism. We open the right eye, and she is now cataleptic on the right side, for the limbs of this side will preserve any attitude given to them, while the muscular hyper-excitability has disappeared; at the same time, on the left side, the muscles are still in the condition appertaining to somnambulism, *i. e.*, hyperæsthetic, for the usual contractures may be brought about in any of the single muscles of that side. If now the left eye is opened, the patient becomes wholly cataleptic; if both eyes are closed, she is wholly somnambulic.

We have here the curious anomaly of hemi-catalepsy and hemi-somnambulism existing at the same moment in the same patient, and occupying indifferently, though each in turn, the one side or the other of the patient's body, according to the will of the operator.

We will at this point relate a most interesting experiment, that of induced aphasia (*aphasie provoquée*). Witt—— is in the state of somnambulism. We ask her to count. She begins, and pronounces in a monotonous manner, one, two, three, four, five, six. We open the *right* eye, and still she continues, seven, eight, nine, ten. At this moment we open the *left* eye, and she has on the instant ceased. We close the left, and she continues, eleven, twelve, thirteen. We open it, and she ceases. This is to say, opening the right eye has no effect upon language, while opening the left eye has obliterated it. We may repeat this experiment in many ways, and on many patients, always with the same result. She may be asked to repeat a verse familiar to her. The right eye is opened and she still continues; the left is opened, and she stops short in the very midst of a word. When the left is closed she finishes this word and continues the verse, unless again interrupted. Or she may be asked to write a verse. The left eye is opened, and the pen pauses on the stroke of a letter; it is closed, and she continues. Opening the right eye has no effect upon her progress.

This is a striking corroboration of the theory that language resides in the left hemisphere, and it is interesting to know that it was communicated by Prof. Charcot to Prof. Broca some months before his death.

At this point we may leave Witt——. Her case is a very typical one, but there are others at Salpêtrière in which the same phenomena may be equally well studied, some exhibiting one stage, some another, in different degrees of perfection. Now and then unusual and exceptional symptoms are presented, as in the following instance of an interesting young girl named F——. Meeting her at any turn of the wards or corridors, Prof. Charcot says: "Look at me a moment, F——." She obeys, and after about five seconds of intent gaze on her part falls slowly backward in a state of universal muscular contracture, in the form of opisthotonos. She is at the same time totally anæsthetic and insensible to all external surroundings. At the end of several hours she returns to consciousness and muscular flexibility. No means of arousing her have yet been found. Prof. Charcot regards this as a third stage of that general condition of which somnambulism and catalepsy form an allied part.

And now a few words as to the methods employed to bring about somnambulism and catalepsy. That commonly in use is by the simple process of holding the finger, or, if preferred, a bright object near to and just above the eyes. This produces the first stage, or that of somnambulism. Another method is to place the patient in front of and facing a brilliant light—an electric or Drummond lamp—and cause her to look intently at it. In a few seconds, or perhaps a few minutes, the cataleptic state supervenes. By closing the eyes the patient then becomes somnambulic and *vice versa*. Or the cataleptic state in many patients may be instantly induced by the "sonorous vibrations" of a large tuning-fork, or by the loud sound from a Chinese gong struck unexpectedly. In fact, those subjected to these experiments seem soon to become so susceptible to any method that they fall at once into one stage or the other upon very slight provocation. With many indeed it is sufficient for the physician merely to close their eyelids suddenly while he is speaking to them, and they are at once somnambulic, and may then, as described, be made cataleptic.

In bringing about this sleep the personality of the operator is altogether unimportant. Prof. Charcot often turns to a visitor or a student and requests him to make the experiment, and in all instances the result is the same. Nor are any manipulations or passes made use of; they are unessential. It is perfectly understood and accepted that these phenomena are entirely subjective. The vagaries of animal magnetism, using the term in the sense that any influence passes from the operator to the subject, find no support at Salpêtrière. Prof. Charcot offers no explanations; he says simply, "facts first, theories afterward." But we may now see, from what has preceded in this letter as well as in others, that the study of somnambulism and catalepsy has been the very natural outgrowth of investigations into the nature of hystero-epilepsy, or we should now say with increased confidence, of hysteria major, for both of these conditions frequently occur spontaneously in hystero-epileptics, not only during the apparently normal interval between series of attacks, but also during the attacks themselves, replacing in the latter instance one or another of the well-known periods. The two directions of study then—somnambulism, catalepsy, and allied states on the one hand, and hysteria major on the other—form a very natural supplement and complement.

But I have already passed beyond the limits of a single letter. My only apology is that it has seemed to me that the readers of the *Record* will be equally interested with me in seeing these matters studied from a practical rather than a visionary standpoint; for these subjects are left too much in the hands of mediums, clairvoyants, and charlatans, who, getting hold of a single available and apparently supernatural phenomena, play upon the wonder of the multitude. Or what is sadder still, such phenomena, having become in themselves a matter of repeated observation, and therefore facts, to the trained physician, are used by him as a basis upon which to erect theories of "magnetic influence," "influence of mind on matter," "mind reading," etc., etc., until, as a result he himself and his readers are led off into the quagmires of the unknown. Be it the charlatan or be it the visionary scientist whom the community has followed beyond its depth, at last comes the opposite swing of the pendulum, and facts become now as much underrated as before overrated. More or less skeptical or more or less speculative seems to be the present state of the medical world's mind in regard to the phenomena described briefly in this letter. Of the measure of the former I will not speak—of the measure of the latter just a word of quotation from a recent medical work of apparently good authority will bear witness:

"Magnetism is the special action that the nervous activity of a person in health, and endowed with a *power* which, in want of a better term, we shall call magnetic, exercises on the nervous activity of another;" or again, "according to the law of influence the nervous activity of the operator vibrates in unison with that of the subject," etc. Here we have the speculative side of the question. But we have neither time nor space to criticise such views. We merely hold them up for contrast. On the one hand a "power" or influence residing in the operator or "magnetizer," and passing through intervening space to the subject; on the other the recognition of the fact that all the phenomena in question are subjective; that they reside in the personality of the patient, and may be excited into activity by a dozen and one methods, or, indeed, occur spontaneously; the recognition of the fact, in short, that we have to deal simply with the symptoms of disease. From this latter point of view the magnetizer, with his passes and counterpasses, his manipulations and his concentration of mind, his "nervous activity" and his special power, retreats into the mists of superstition, while at the same moment the physician steps forth into a field of investigation strictly within the domain of scientific medical study. Such, at least, are some of the reflections suggested by our morning clinic at Salpêtrière, and inspired also, I may add, with equal ability on our own side of the Atlantic.

WILLIAM J. MORTON, M.D.

PARIS, August 20, 1880.

A NEW METHOD FOR PROLAPSUS ANI.

PROF. KEHRER, of Giessen, Germany, has devised a new method for the treatment of prolapsus ani, and reports two successful cases with the same. After briefly alluding to the ordinary methods now in vogue, and commenting upon their frequent inefficiency, he proceeds to explain how he was led to attempt the new method. This was by the simple consideration of a rubber ring, which, owing to frequent over-distention, has ceased to act in a proper manner. If a knot be tied into such a ring, or if a loop of it be secured by a string, its former action will be restored. This simple principle he applied to the over-distended sphincter and in cases of prolapse. That is, he folds together a portion of the sphincter, and after excision of its mucous covering secures the folds by means of a firm suture. Thus a portion of the ring is eliminated, and the caliber narrowed correspondingly. In the two cases which were subjected to this operation a speedy cure took place.—*Deut. Med. Woch.*

NITRITE OF AMYL IN CONVULSIONS.

DR. L. F. PITKIN gives in the *Medical Record* an account of a case of convulsions in a child which yielded to the inhalation of a few drops of nitrite of amyl, although chloroform and ether failed to control them. A subsequent examination of the patient revealed the fact that the convulsions were due to some cerebral lesion. Dr. Pitkin states that he has used the nitrite of amyl in a large number of cases, and, with few exceptions, it has been followed by good results. He usually administers five minims, dropping it into a small sponge, and allowing the patient to inhale it. It causes the face to flush, and stimulates the lachrymal glands to a considerable extent. Great care should be used in the administration of the drug, as serious consequences might result from its injudicious use.

HELP FOR RED NOSES.

WHEN alcohol, or the force of circumstances, has brought to a man a red nose, it has generally been considered irremediable. He tries, perhaps, a few bran poultices, and then abandons himself to the inevitable rubescence. Mr. Malcolm Morris reports (*Brit. Med. Journ.*) considerable success with acne rosacea, when thus affecting the nose, through the use of linear scarifications. He had tried this method in the way recommended by Mr. Squire as a remedy for port wine mark, but failed of doing any good. Applying it to other conditions, however, he had much better success. His plan is to scarify the affected part in parallel lines, allowing some blood to flow. He repeats the operation from ten to twelve times.

AMMONIA IN HEALTHY PERSONS.

By A. ADAMKIEWICZ.

IN experiments with sal ammoniac the ammonia disappeared from the system, probably as urea. Sal ammoniac increased the decomposition of the albuminoids. Diabetic patients form sugar from the albuminoids. The ingestion of sal ammoniac diminishes the excretion of sugar.—*Virchow's Archiv.*

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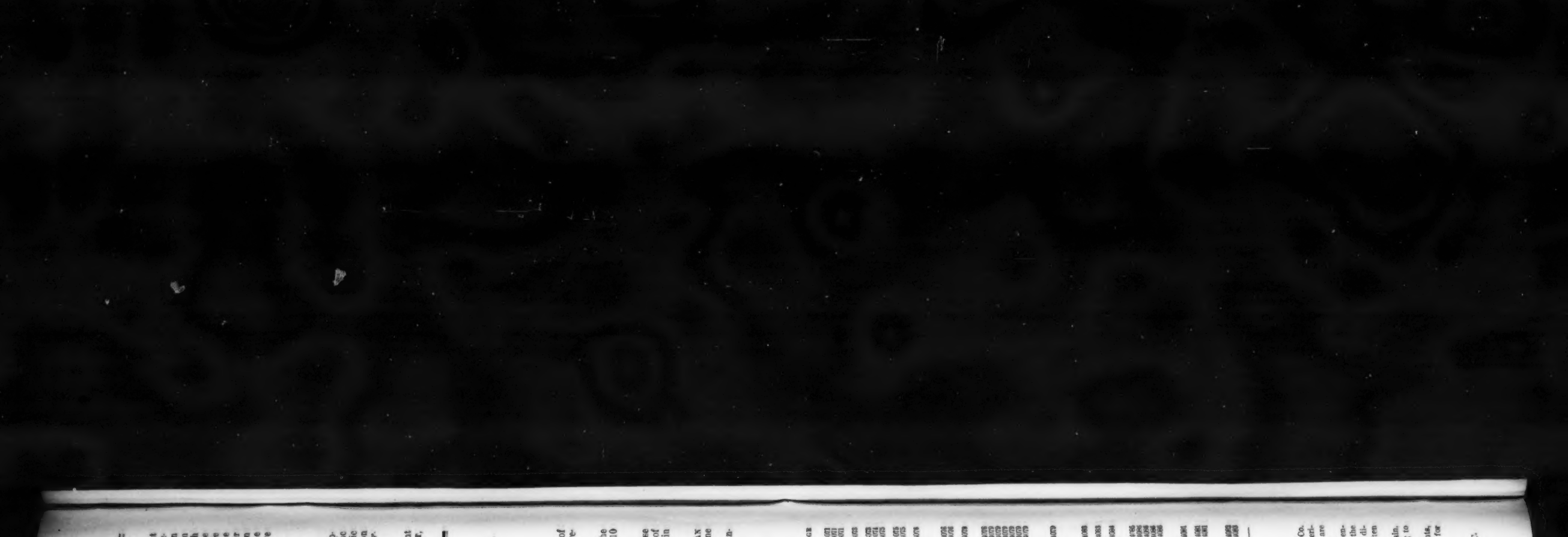
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